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Reports
Taylor,
C. A.

GERMINATION BEHAVIOR OF TREE SEEDS

by

Carl A. Taylor

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Lincoln, Nebraska

February 4, 1954

Dear Fellow Worker,

About fifteen years ago Carl A. Taylor, Nurseryman with the Prairie States Forestry Project, U. S. Forest Service, initiated a series of seed germination tests with approximately 20 tree and shrub species commonly used in shelterbelt plantings in the Great Plains. The Forest Service published his results in 1941, mainly for in-Service use.

The information and data in this publication should be useful to forestry and horticultural workers in the Great Plains, and a limited supply has been reproduced for this purpose.

A copy is hereby attached for your use and information. We hope you will find it helpful and worthwhile.

Very truly yours,

A. E. Fehr

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F O R E W O R D

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"Germination Behavior of Tree Seeds," by Carl A. Taylor was published by the U. S. Forest Service, Prairie States Forestry Project, in May, 1941. The original booklet is now out of print, and only a few copies remain available.

Since it contains much valuable data of considerable potential use to workers in the Great Plains, the Soil Conservation Service has reproduced the contents for the benefit of interested parties who are working with trees and shrubs in this area.

Prepared by Forestry & Nursery Divisions
Soil Conservation Service
Lincoln, Nebraska
January, 1954

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UNITED STATES DEPARTMENT OF AGRICULTURE
Forest Service
Prairie States Forestry Project

GERMINATION BEHAVIOR OF TREE SEEDS

Carl A. Taylor, Chief Nurseryman
Nebraska

The following data is submitted largely in the form of germination graphs, with the objective of revealing the rate of emergence as well as the percentage of viable seeds in the various lots and species tested.

In most cases, the graphs are of parallel tests of several lots of seed which presumably were similar at the time of collection, but in which the degree of dormancy, germinative energy or percentage of viable seed had been influenced by variations in the methods of extracting or treating the seed. Other graphs show routine tests of our regular supply of seed, and are now of value only as indications of the behavior of the species at that stage.

Except where noted, the results are based on planting of representative samples of the seed in flats containing a mixture of sand and peat. All sowings of the series were made in the same flat to assure similar conditions of moisture, temperature, and texture of the medium used. Since the tests were largely used to anticipate results to be expected under favorable nursery conditions, no special control methods such as sterilization of the material, use of distilled water or absolute control of temperatures were employed. Some of the winter tests were run in a warm room, but most were in a germination box equipped with electric heating cable and thermostat.

The charts are arranged by species in the alphabetical order of their common names. It will be found that often the significant results pertaining to one species are repeated in others. For instance, the benefits of moderate fermentation just prior to or during the early stage of after-ripening of Hackberry, also occur in some degree with Russian Olive and other drupes. Other instances are the better retention of viability when the seed is stored at low temperature in tightly closed full containers; and the use of sulphuric acid to render hard seed coats permeable to moisture upon sowing or stratifying.

Nurserymen or others considering the charts as a guide to field practice should realize that in many instances, the shape of the graph curve is of more practical importance than the ultimate germinations shown. Especially in the case of stratified seed which is sensitive to drying, initial germinations represented by the first upswing of the line are those which must be depended upon for the field stands. When the row ridges are raked down, drying, soil disturbance, suppression, and other natural hazards destroy the straggling germinations which occur in the optimum environment of the tests. This factor increases the importance of pre-sowing treatments which shorten the period during which most of the seeds germinate.

The accompanying records are not intended to represent a systematic administrative study of the subject, but are just observations made from time to time in connection with the regular handling of seed at the nursery and seed extractory of the Prairie States Forestry Project at Norfolk, Nebraska.

Summary of Conclusions and Comments, by Species

AMERICAN ELM (Ulmus americana)

While this seed is commonly sown immediately after collection and brief drying, it can be stored until the following season by keeping it in tightly closed full containers held at temperature of 40°F. or lower. This practice permits sowing earlier than the ripening of the current crop, and assures a supply of seed in event of the crop being killed by late freeze. Storage induces partial germ dormancy which is relieved either by thirty-day stratification at after-ripening temperature or by soaking a day or two in water. The latter method is more rapid and convenient for control of sowing densities. Dewinging the seed by threshing in our macerator is desirable practice, to permit mechanical drill sowing, to conserve storage space, and to improve the keeping qualities of the seed by better exclusion of air in the compact seed. (See plates Am-1, 2, 3, and 4)

AMERICAN PLUM (Prunus americana)

Stratification for 4 to 5 months at 34-41°F. is necessary to relieve the germ dormancy. Don't be misled by seed coats opening at 2½ to 3 months, the seed is not ready. One commercial nurseryman claims he obtains complete after-ripening by stratifying in moist sawdust for 3 months, but I have not verified this. Acid treating to shorten the stratification period by increasing the permeability of seed coats did not show any beneficial results in the limited trial used, though it may be worth looking into for emergency use. Plum seed keeps well in ordinary storage at room temperature. Boyce Thompson Institute for Plant Research reports that seed so stored increased in viability up to 26 months, and still retained half of its initial viability up to 46 months. As with Chokecherry and other drupes, fermenting or rotting is not injurious to the seed unless continued to the point of forming acetic acid. Seed from fruits so green that they did not turn pink upon further holding after picking, after-ripened well in 4 3/4 months stratification and germinated 96%. (Pl-2 and Pl-3). A safe rule for collectors is to crack upon a few seeds of dubiously green fruit, and if the membrane covering the kernel has changed from white to light tan or brown, the seed is sufficiently mature. Fully ripe plums are easier to macerate and extract the seed, but much more likely to heat and sour in transportation or holding awaiting extraction. Where collections are at a distance from the extractory, it is safer to collect when most of the fruit is pink to light red but still hard. Lake States Experiment Station reported on the basis of tests with plums from the Cass Lake Minnesota area that the seed germinates to much higher percentage at continuous temperature of 50°F. than at higher temperatures such as 50-77°F. range. Fully after-ripened plum seed from Nebraska germinated to as high percentages and in much shorter period at temperature of 80°F. for 15 hours a day and 70°F. the remaining 9 hours a day. Seedling growth was also much better at the higher temperature.

BLACK LOCUST (Robinia pseudoacacia)

The hard seed coats are rendered permeable to moisture by placing in sulphuric acid (without dilution) for ½ hour to 1½ hours, depending on the particular lot of seed, and the room temperature of the acid, high temperatures accelerating the action of the acid. Note in test Bl-1 that the benefits of treatment for securing rapid even emergence of the viable seed are even greater than the gain in ultimate percentage of germination. In Bl-2 it appears that acid treated seed did not deteriorate during one year's storage in closed container at room temperature.

CARAGANA or SIBERIAN PEATREE (Caragana arborescens)

This seed requires no pre-sowing treatment for high percentage germination, but for good results, sowing should be delayed until the soil is warm. New seedlings emerging in very hot weather are not injured by the heat.

CHINESE ELM (Ulmus pumila)

This seed keeps well for at least a year, if kept in tightly closed full containers held at low temperature. Comparative losses in viability of whole and dewinged seed by sealed and "open" storage are shown in Chi-1. The advantages of dewinging to permit drill sowing and more compact storage as mentioned under American elm, apply also to this species. However, the soaking of carry-over seed is neither necessary or feasible as the inner seed coat of dewinged Chinese elm is gelatin-like material which swells and makes the seed slimy. Mr. Ernest Wright plans to study the physical and functional properties of this inner seed coat, as to whether it forms a favorable culture medium for damping-off organisms.

EASTERN REDCEDAR (Juniperus virginiana)

This seed has germ dormancy which is relieved by stratification for 110 to 120 days at 35-40°F. Very rapid increase in viability occurs toward the culmination of the stratification period. (See Ce-1). Seed germinating 26% at 3 months' stratification, germinated 73% 20 days later; and another lot germinating 12% at 3 months, germinated 46% 20 days later. Since emergence gets well under way in five or six days after sowing of thoroughly after-ripened seed, it is advisable to hold up field sowing until germination tests show that the seed is "ready to go" even though a minor percentage of the seed may show premature sprouting in cold storage. Imperfect cleaning of the seed of the resinous material in the berry impedes entrance of moisture to the embryo and may cause slow or uneven after-ripening. The best method found so far is to soak the berries for a day or two in a solution of 1 teaspoonful of Lewis lye per gallon of water, macerate the berries and separate the good seed by flotation; then re-soak the clean seed for a day in similar solution, stirring a few times during the treatment, and wash clean. Seed so cleaned gives consistently better results. Naptha as a solvent was tried with negative results. Etching with sulphuric acid to remove the resin and render the seed coat itself more permeable was tried in a limited way. It seemed to hasten after-ripening and at 60 days stratification had apparently reached its germination peak which was not as high percentage as that attained by

untreated seed stratified for 90 days. If mid-winter changes in sowing schedules require late preparation of seed for spring sowing, acid treating may be a useful expedient to hasten after-ripening. Mechanical scarifying in the Denbeigh type disc scarifier proved unnecessary and injurious, the germination percentages being progressively lower as the period of scarification increased. (Ce-1 and 2). This does not apply to Rocky Mountain Juniper (Juniperus scopulorum).

GREEN ASH (Fraxinus pennsylvanica lanceolata)

The seed has dormancy which is relieved by soaking in water at room temperature for three weeks or longer, changing the water daily for the first week and several times a week thereafter for aeration, and to prevent souring. The prolongation of soaking increased the germination from 25% (1 day soaking) to 90% when soaked three weeks. Stratification for a month at 35-40°F. gave nearly as good results, but sowing of stratified seed is somewhat less convenient. (Plate As-3). Fall sowing also yields good results. Storage for more than one year is not recommended generally, though older seed may give good results by fall sowing. Prolonged storage apparently induces persistent dormancy which is overcome by wintering in the ground. The seed tested (As-1) which germinated 20% to 30% after long soaking and showed very sluggish seedling growth in field sowing, yielded vigorous seedling growth and high percentage of germination from a sowing the previous fall. Seedlings from the early spring 1940 sowing of 1938 seed were passed up in growth by a sowing five weeks later of 1939 seed in the same block. Dewinging in the macerator after the seed becomes thoroughly dry permits more compact storage, though too severe threshing may damage the germ, which is toward the wing end of the embryo.

HACKBERRY (Celtis occidentalis)

Wide variations in the behavior of this seed lead me to believe that fermentation of the pulp on the seed prior to or during the early stages of the after-ripening period is necessary, or at least highly beneficial for bringing the seed into viable condition. The pulp is high in sugar and low in acid content, so fermentation does not start readily under some conditions; and the lots of seed so involved have shown little if any germination after periods of stratification which are ordinarily adequate (See Ha-1, 2, 3, 4, 5, 6, and 7). Depulping is highly desirable. Apparently the breaking of the skins of the drupes and exposing the pulp to organisms in the soil or stratification medium helps to start fermentation if temperature is not too low. (Ha-2, 3, and 5). The limited amount of pulp clinging to the "clean" seed limits the action to an amount which does not produce too severe heating. However, where whole berries stratified in peat have heated to temperatures of 95-110°F. for ten days, they still germinated to higher percentages than a parallel lot on which heating by fermentation had been completely suppressed. (Ha-6). Hackberries of the 1936 crop were particularly prone to go through stratification without any fermentation, and these showed 0% to 7% viability after 3½ months stratification, as compared with 50% to 60% germination of the same seed depulped. The results were repeated in several states and at the Plumfield Nurseries, Fremont, Nebraska, where an exceedingly thin stand was obtained from a fall sowing of 1936 whole berries. Possibly the 1936 drought caused an unusually high concentration of sugars in the fruits.

At any rate, the difference between behavior of depulped seed and whole fruits was more marked that year, though always a considerable factor. The seed coats are brittle and depulping in the macerator causes considerable loss by cracking unless the speed and water supply is adjusted carefully, but this loss is more than offset by the increase in percentage of seed which becomes viable in after-ripening. Experiment Ha-7 covers parallel lots stratified with and without depulping and with varying periods of fermentation.

HAWTHORN (Crataegus coccinea)

This seed has impermeable seed coat and germ dormancy. Treating with sulphuric acid for 1 to 2 hours, as described under Honeylocust, and followed by stratification for 3 months at 34-40°F. will obtain good germination from spring sowing of seed collected the previous fall. Otherwise it will lie in the ground over summer and come up the second spring.

NORTHERN CATALPA (Catalpa speciosa)

This seed is sown without pretreatment, when the soil has become warm. The viability and keeping quality of this seed is influenced adversely by collecting before the pods are ripe and brown.

OSAGE ORANGE (Toxylon pomiferum)

Stratification for four to six weeks is optimum presowing treatment for this seed, though soaking for 18 days or longer, changing the water every day or two yields nearly as good results (Os-1). Sowing should be made about corn planting time, when the soil is warm.

PONDEROSA PINE (Pinus ponderosa)

Thirty days stratification at 34-40°F. produced much more rapid germination and consequently a more even-aged stand of seedlings, than from dry sown seed. (Po-1). However, stratified seed is difficult to sow in mechanical drills and may be injured by use of sulphuric acid on the sowing beds. The dry sown seed ultimately germinated to as high percentage as the stratified seed and in this respect Ponderosa acts differently than Shortleaf, Longleaf, and Loblolly pine. Acid treating, which was reported to give favorable results with Western White Pine seed, gave negative results for Ponderosa.

QUAILBUSH or AROMATIC SUMAC (Rhus trilobata)

Has both impermeable seed coat and mild germ dormancy. Treating in sulpluric acid for one hour, followed by sixty days stratification at 34-40°F. yielded 86% germination within ten days after sowing. If acid treating is omitted, long periods of stratification are required and germinations are of lower percentage. (Q-1).

ROCKY MOUNTAIN JUNIPER (Juniperus scopulorum)

This species of seed has both germ dormancy and impermeable seed coat. Usual treatment is to bury seed mixed with clean sand during the first summer, so that the soil organisms can partly disintegrate the seed coat; then fall sow or stratify at 34-40°F. for after-ripening of the germ. If necessary to spring sow seed of the previous fall's collection, partial germination may be obtained by acid treatment for 30-minute period, prior to stratification at after-ripening temperature. Also mechanical scarification by rubbing a small quantity of seed with a brick on a rough concrete slab is used by some nurserymen with good results, though this is laborious and expensive. Further trials of acid etching for various periods and/or stratification at 70-85°F. for periods of 1 to 3 months prior to stratification at low temperature, are being tried and results will be included in later amendments to this handbook.

RUSSIAN MULBERRY (Morus alba tatarica)

Storage in sealed full containers holds most of the viability of this seed for at least a year. Storage at low temperature is better only if the seed is in tight full containers, otherwise sealed storage at room temperature should be used. Seed left open in cold storage is poorer than seed so stored at room temperature. (M-1). Cold stored seed in open containers, or of seed improperly dried, will lose viability rapidly upon removal to warm temperature. (M-1). Fermentation of mulberries for a day or two at moderate temperature yields seed of higher viability as well as facilitating extraction. When fermentation reaches the point when the alcohols are converted to acetic acid, the seed is killed. This stage can easily be detected by the vinegary smell. Mulberry is more sensitive to acetic acid injury than seeds having a heavier seed coat such as chokecherry, plum, and Russian olive. Mulberry seed is more sensitive than most species, to germination temperatures. Optimum is around 90-95°F., at which temperature most of the viable seed emerges on the 5th to 9th days after sowing. At "spring" temperatures such as 50°F. minimum night temperature and 65-75°F. day time temperatures, the carry-over seed may enter a rest period of from two to four weeks before starting to germinate. Germination following such rest period is quite rapid if the seed dormancy had been relieved by a month's stratification at after-ripening temperature prior to sowing; otherwise it may be spread out over another two or three weeks. Experiment M-2 shows the response of stratified, soaked, and dry sown seed in germination at several temperature ranges. The size of seed did not make much difference with respect to percentage or rate of germination; but three weeks after emergence the seedlings from the largest seeds of the lot were about twice as large and with much better root systems than those from the small seed.

RUSSIAN OLIVE (Elaeagnus angustifolia)

As with Hackberry, this seed shows higher percentage of germination and more germinative energy if the berries are depulped and the pulp residue on the "clean" seed allowed to ferment at the beginning of the after-ripening period. Whole berries stratified in either sand or peat are apt to heat severely and long enough to injure the seed, though temperatures of 90-100°F. for a few days do not

cause serious injury. Those temperatures prolonged for several weeks were relatively more injurious than for Hackberry; probably because fermenting Hackberry pulp is not inclined to turn to acetic acid. In a number of tests, seed which heated to temperatures of 80-85°F. for limited periods germinated to higher percentages than where no fermentation occurred. (R-4).

THORNLESS HONEYLOCUST (Gleditsia triacanthos inermis)

This seed has impermeable seed coat type of dormancy, which is relieved by treatment with sulphuric acid (without dilution) for one to two hours, depending on hardness of seed coat and temperature of the acid. The action of the acid is accelerated by heat and stirring, so a test of a small sample of the seed is not a reliable index of the best length of treatment for a large batch. The larger lots retain more heat generated by the chemical action. If the treatment is carried to the point where the acid eats entirely through the seed coat and encounters the jelly-like layer surrounding the embryo, a further rapid heating and foaming of the acid occurs. This should be avoided. To determine the proper length of treatment, a few seeds of the batch being treated are removed from time to time and the blackened acid washed off. When the treatment is adequate, there will be seen hair lines crosswise of the seed. The seed is then washed by adding small quantities of seed to large quantities of water and stirred in changes of water until no trace of acid taste remains on the seed. It may be sown at once or dried for sowing later. The treated seed will keep for several years if kept dry. Prompt germination of 90% to 95% of acid treated seed is common.

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa)

Much of the difficulty experienced with this seed in the past with respect to preparing the seed for spring sowing arose from the different degrees of dormancy of the seeds comprising the lot. Fully after-ripened seeds will sprout at temperatures as low as freezing, with the result that throughout the sowing season, part of the seed had sprouted, part was ready to sow, and part still dormant. Furthermore, the premature sprouting causes some heat which accelerates further sprouting and heating to an extent which kills the seed. The degree of germ dormancy seems to be related to the severity of sun-drying. The seeds which are exposed to hot sunlight longest become more deeply dormant than the others. On the other hand, holding the seed moist from the time of cleaning is usually disastrous. At warm temperature the moist seed moulds, heats and spoils, and at low temperature after-ripening sets in, so the seed sprouts before spring sowing time. Coating the freshly cleaned damp seed with melted paraffin to keep it damp without moulding was unsuccessful. The most satisfactory handling seems to be to dry the seed indoors or in solid shade, until the outside of the seed is dry and it takes on the characteristic straw color. If the seed is to be sown that fall or stratified that winter, any ordinary storage is satisfactory, but seed which is to be carried over to another year should be put into sealed or tight fitting metal drums and preferably held at low temperature. Storage continuously below freezing is best and at this temperature the loss of viability by open storage is not so serious as at temperatures above freezing. At temperatures of 34-41°F. the deterioration from open storage is greater than for sealed storage at warehouse temperature, presumably due to the higher humidity of the

cold storage rooms. In Boyce Thompson Institute's bulletin "Life Span of Seeds," it is established that low temperature and low humidity are important factors for retention of viability in seeds generally. At sub-freezing temperatures, the humidity is reduced by frost precipitation and in addition the respiration rate is very low. (Cho-1). Moderate fermentation or rotting of Chokecherries before extracting the seed is not injurious and seems to produce seed of higher viability than seed from fresh berries. (Cho-1).

AMERICAN ELM (Ulmus americana) Am-4 (No graph)
F-39-3

Purpose of test: 1. Relative effectiveness of soaking seed 2 days, or stratification 1 month at 35-40°F. as a pre-sowing treatment of stored American elm seed; 2. Treatment with Vitamin B_1 before or after stratification or both; 3. Test the relative damping off potential of the Norfolk Nursery soil.

DATA: All seed used was from the same lot of dewinged American elm which had been stored since the previous June at about 40°F. in a full, tightly closed but not air-tight drum. 100 seeds of each of the following lots were sown in sterile sand-peat mixture, and in soil from the nursery. Half of each lot in soil were watered weekly with solution of Vitamin B_1 using 1 drop of "concentrated" solution to 1 gallon of water. (The notes on the mixing of the concentrated solution have become lost, but it is believed that a lump of the Vitamin B_1 the size of the end of a match was added to two ounces of water.) The lots of treated seed were as follows: (12/19/39).

I Stratification:

1. Soaked 1 day then stratified 30 days at 35-40°F.
   a. Planted at end of stratification period.
   b. Soaked 12 hrs. in Vitamin B_1 sol. of 5 drops stock sol.: 1 qt. water.
2. Treated 1 day in Vitamin B_1 solution 8 drops stock sol.: 1 qt. water, then stratified in peat moistened with solution of 2 drops stock: 1 gal. water carried at 35-40°F. for 30 days.
   a. Planted at end of stratification period.
   b. Soaked 12 hrs. in solution same as 1-b above.

II Soaking Just Prior to Sowing:

1. Soaked 1 day in water at room temperature.
2. Soaked 1 day in Vitamin B_1 5 drops of stock sol: 1 qt. water.

III Control:

No treatment, seed sown dry.

Lot No.	Treatment	Germinations: Sown in sterile sand and peat (Percent)	Sown in soil (Percent)
I-1a	Stratified 30 days	15	-*-
1b	" & treated Vit. B_1	23 (-3)	8 (-1)
2a	Tr. Vit. B_1 then stratified	24 (-2)	6
2b	" " " " then treated	23 (-2)	-*-
II-1	Soaked in water 1 day	58	2
II-2	" Vit. B_1 sol. 1 day	54	13 (-10)
III	No treatment	21	1

Figures in ( ) indicate damping off losses.
-*- indicates no sowing made.

CONCLUSION: 1. No significant benefits from Vitamin B_1 were observed.
2. One day's soaking of the seed more than doubled the germination percentage.
3. Stratification was much less effective than soaking in this test.
4. High damping off potential of the nursery soil used is indicated.

AMERICAN ELM (Ulmus americana) Am-4 (No graph)
F-39-3

Purpose of test: 1. Relative effectiveness of soaking seed 2 days, or stratification 1 month at 35-40°F. as a pre-sowing treatment of stored American elm seed; 2. Treatment with Vitamin B_1 before or after stratification or both; 3. Test the relative damping off potential of the Norfolk Nursery soil.

DATA: All seed used was from the same lot of dewinged American elm which had been stored since the previous June at about 40°F. in a full, tightly closed but not air-tight drum. 100 seeds of each of the following lots were sown in sterile sand-peat mixture, and in soil from the nursery. Half of each lot in soil were watered weekly with solution of Vitamin B_1 using 1 drop of "concentrated" solution to 1 gallon of water. (The notes on the mixing of the concentrated solution have become lost, but it is believed that a lump of the Vitamin B_1 the size of the end of a match was added to two ounces of water.) The lots of treated seed were as follows: (12/19/39).

I Stratification:

1. Soaked 1 day then stratified 30 days at 35-40°F.
   a. Planted at end of stratification period.
   b. Soaked 12 hrs. in Vitamin B_1 sol. of 5 drops stock sol.: 1 qt. water.
2. Treated 1 day in Vitamin B_1 solution 8 drops stock sol.: 1 qt. water, then stratified in peat moistened with solution of 2 drops stock: 1 gal. water carried at 35-40°F. for 30 days.
   a. Planted at end of stratification period.
   b. Soaked 12 hrs. in solution same as 1-b above.

II Soaking Just Prior to Sowing:

1. Soaked 1 day in water at room temperature.
2. Soaked 1 day in Vitamin B_1 5 drops of stock sol: 1 qt. water.

III Control:

No treatment, seed sown dry.

Lot No.	Treatment	Germinations Sown in sterile sand and peat Percent	Sown in soil Percent
I-1a	Stratified 30 days	15	-*-
1b	" & treated Vit. B_1	23 (-3)	8 (-1)
2a	Tr. Vit. B_1 then stratified	24 (-2)	6
2b	" " " " then treated	23 (-2)	-*-
II-1	Soaked in water 1 day	58	2
II-2	" Vit. B_1 sol. 1 day	54	13 (-10)
III	No treatment	21	1

Figures in ( ) indicate damping off losses.
-*- indicates no sowing made.

CONCLUSION: 1. No significant benefits from Vitamin B_1 were observed.
2. One day's soaking of the seed more than doubled the germination percentage.
3. Stratification was much less effective than soaking in this test.
4. High damping off potential of the nursery soil used is indicated.

CHINESE ELM (Ulmus pumila) Chi-3 (No graph)
F-39-2

Purpose of test: 1. Relative effectiveness of soaking the seed 1 day or stratification 1 month at 35-40°F. as a pre-sowing treatment of year-old Chinese elm seed; 2. Treatment with Vitamin B_1 before or after stratification or both; 3. Test the damping off potential of the Norfolk Nursery soil.

DATA: Seeds used were from a lot of dewinged Chinese elm seed which had been stored since the previous June, at about 40°F. in a full, tightly closed, but not air-tight drum. 100 seeds of each of the following lots were sown in sterile sand-peat mixture and in soil from the nursery. Half of each lot in soil were watered weekly with solution of Vitamin B_1 using 1 drop of stock solution per gallon of water. (The notes on the mixing of the stock solution have become lost but it is believed that a lump of Vitamin B_1 the size of the end of a match was added to two ounces of water). The following lots of treated seed were sown 12/19/39.

I. Stratification:

1. Soaked 1 day then stratified 30 days at 35-40°F.
   a. Planted at end of stratification period.
   b. Stratified seed was soaked 12 hrs. in Vitamin B_1 solution of 5 drops stock sol: 1 qt. water.
2. Treated 1 day in Vitamin B_1 sol. of 8 drops stock: 1 qt. water, then stratified in peat moistened with solution of 2 drops stock: 1 gal. water, carried at 35-40°F. for 30 days.
   a. Planted at end of stratification period.
   b. Soaked 12 hrs. in solution same as 1-b above.

II Soaking Just Prior to Sowing:

1. Soaked 1 day in water at room temperature.
2. Soaked 1 day in Vitamin B_1 sol. 5 drops stock: 1 qt. water.

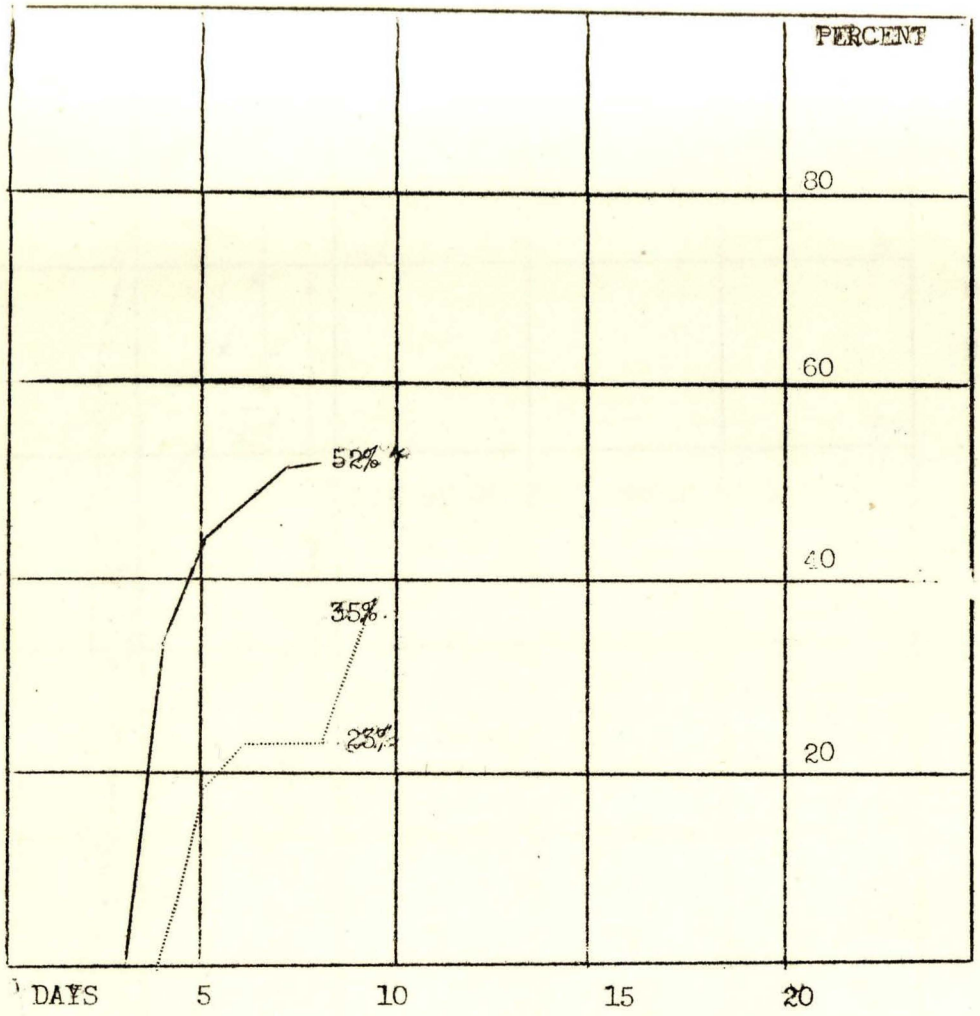
III Control

No treatment, seed sown dry.

Lot No.	Treatment	Germinations: Sown in sterile sand and peat (Percent)	Sown in soil (Percent)
I-1a	Stratified 30 days	55	0
1b	" 30 days then treated Vit. B_1	54	7
2a	Vitamin B_1, stratified	1	0
2b	" " " then treated	*	2
II-1	Soaked in water 1 day	75	3
II-2	" " Vitamin B_1 1 day	68	11 (4)
III	Control, no treatment	74	2

* indicates no sowing made.
Figures in () indicate number of emerged seedlings which damped off.

CONCLUSION: Vitamin B_1 treatments were of no value, some harmful. Neither soaking or stratification increased the percentage of germination. Soaking makes this dewinged seed slimy and hard to handle. The nursery soil had high potential damping off, which may destroy all of the crop, under favorable weather conditions.



AMERICAN ELM (Ulmus americana) Am-1
F-40-2

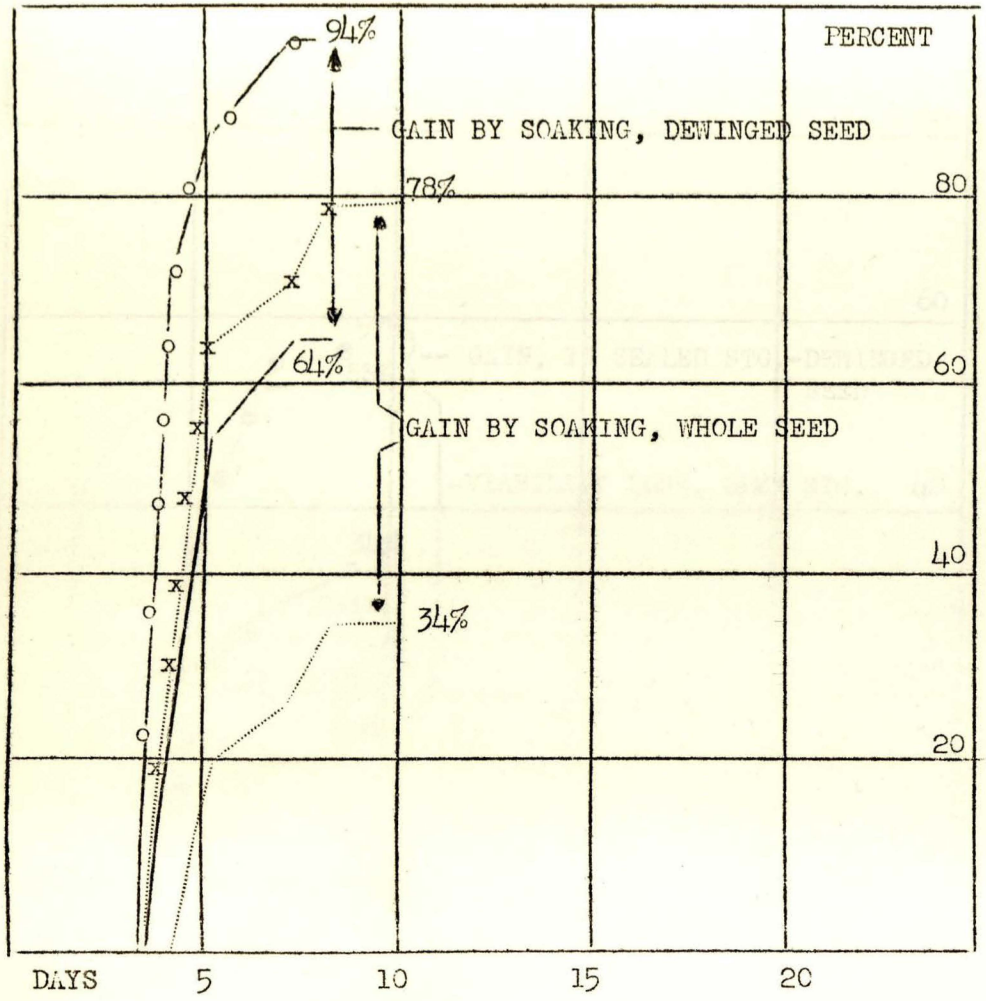
Routine test of main stores, about four months after collection.

DATA: This dewinged American elm had been stored at 35-45°F. in metal drum having close fitting, but not air-tight lid. Random sample from the interior of the lot was used for sowing. Part of the sample was soaked 2 days, changing water at the end of the first day. Sown 10/13/40.

CONCLUSION: This test confirms previous evidence of the benefits of soaking American elm seed which has been carried in storage. Germination percentage of the soaked seed was not as high as sometimes obtained.

———— Seed soaked 2 days before planting.
..... Seed sown dry.

AMERICAN ELM (Ulmus americana)
F-39-3

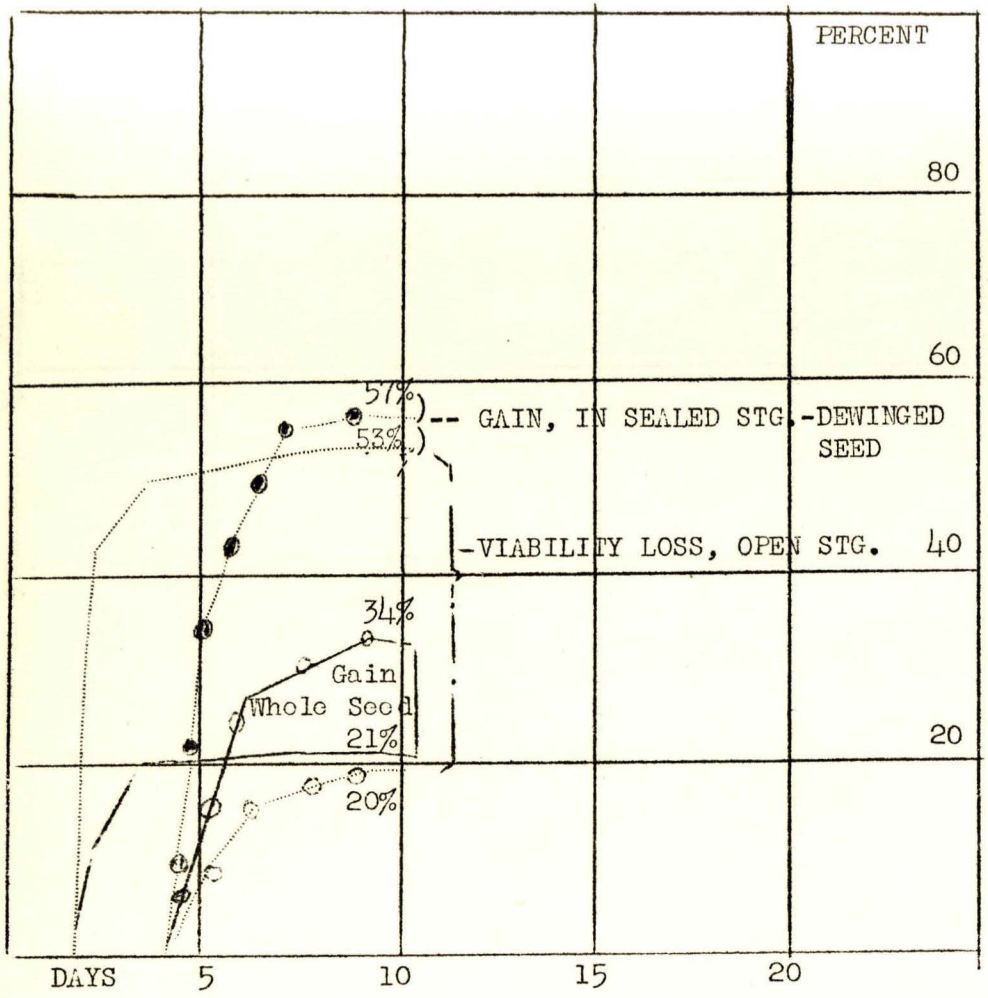


—o—o—o— Dewinged seed soaked 2 days, 1 yr. closed storage.
———— Dewinged seed sown dry, 1 yr. closed storage.
. . . . . Whole seed sown dry, 1 yr. closed storage.
..x..x..x.. Whole seed soaked 2 days, 1 yr. closed storage.

Soaking the seed before sowing, to obtain faster and more germinations. Determines whether dewinging by threshing in macerator at time of collection impairs the keeping qualities of the seed.

DATA: The supply of whole and dewinged seed was stored at 35-45°F. in the same metal drum which had a tight fitting but not air-tight lid. Storage was from early summer of 1939 until 5/10/40. Drum was full. Random samples of the whole and dewinged seed were taken; and part soaked two days, changing the water at the end of the first day. Sown 5/12/40 in a flat of sand-peat mixture which had been sterilized by boiling.

CONCLUSIONS: Soaking improves the viability of year-old American Elm seed up to more than double. Dewinging does not impair the keeping quality, but improves the viability. (Removal of empty seed during dewinging process was discounted by sowing only filled whole seed).



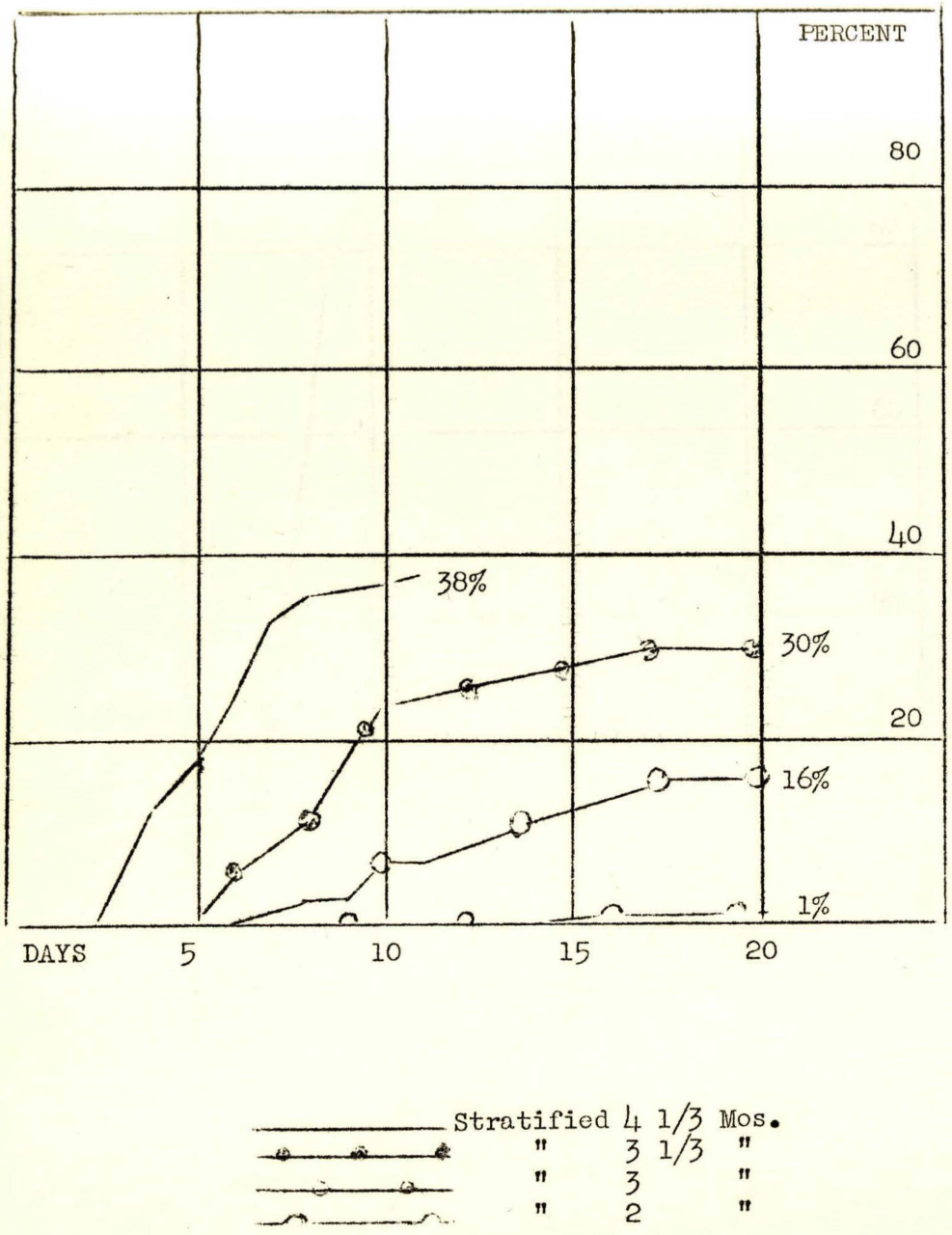
Whole seed sown dry 6/29/39
Whole seed sown dry 5/7/40 (sealed stg.)
Dewinged seed sown dry 6/29/39
Dewinged seed sown dry 5/7/40 (sealed stg.)
Dewinged seed sown dry 5/7/40 (open stg.)

AMERICAN ELM (Ulmus americana) Am-3
F-39-3 (Special lot)

Comparison of open and closed storage at low temperature. Relative viability of whole and dewinged seed at beginning and end of 1 year's storage.

DATA: Seed from our regular supply at time of collection was set aside for a longevity test to continue for a number of years. Whole and dewinged seed were each packed tightly into half-pint cream bottles which were capped but not sealed during the first year. Lots of each were also stored in muslin sacks. Storage beginning 6/20/39 was in a commercial cold storage room at 35-45°F. As the room is used occasionally for chilling poultry, the humidity is rather high. Initial sowings of each lot were made 6/29/39. Second sowing of each was made 5/7/40. Both sowings were of dry seed, and agree closely with the dry-seed sowings in Am-2, so estimate of germinations which would have been obtained by soaking is apparent. The bottles were sealed with paraffin 5/7/40, for further storage.

CONCLUSION: Storage in tightly closed full containers is very important, and may even increase the initial viability. Storage in cloth sacks lost up to 62% of the initial viability. Dewinged seed germinated faster and to much higher percentage at the beginning and end of the storage period, as compared with whole seed.



AMERICAN PLUM (Prunus americana) P1-1
F-36-11

Routine tests show increase in viability up to 4 1/3 months of stratification at after-ripening temperature and suggest longer stratification.

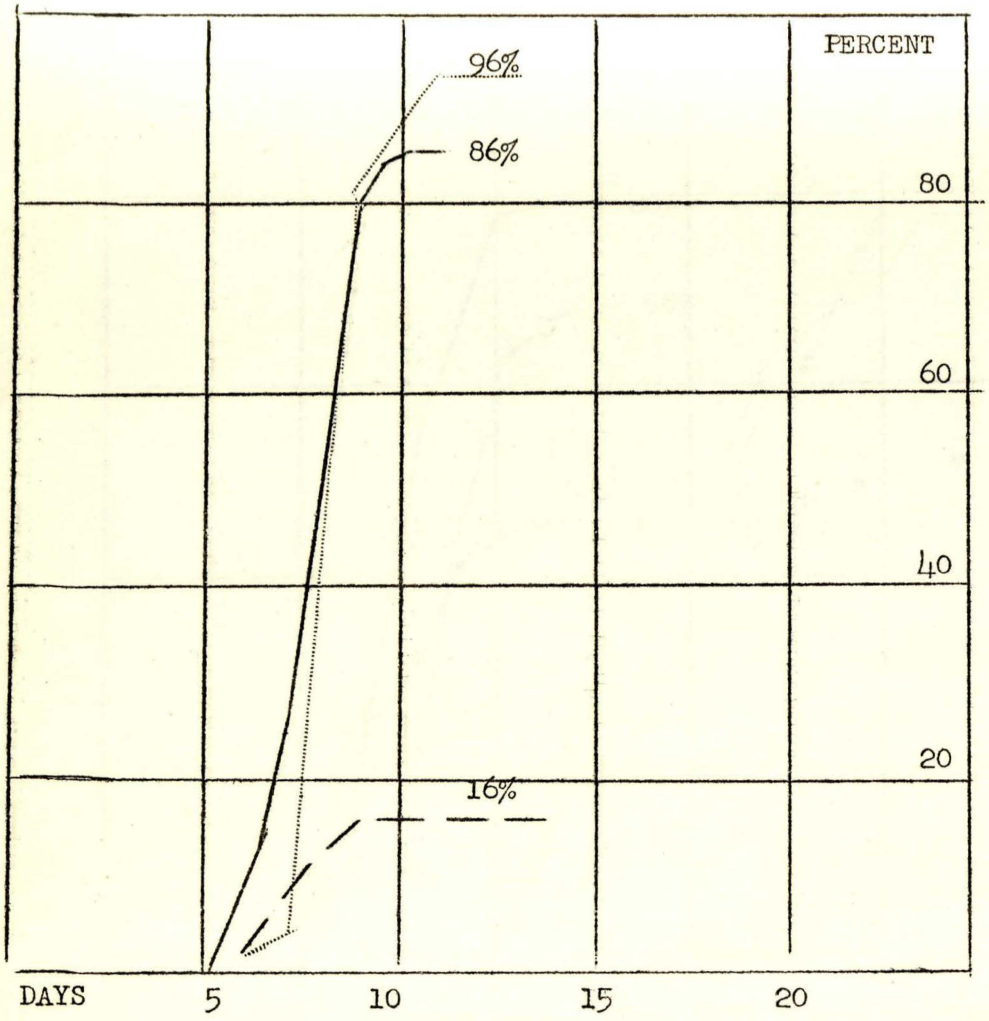
DATA: Random samples of main stores stratified 12/19/36 in peat and sand, and held at approximately 40°F., were sown at the end of 3 months, 3 1/3 months, and 4 1/3 months. The sowing at 4 1/3 months was duplicated with seed from the tops and bottoms, respectively, of the tall ice cans in which the stratified seed was stored. As the germination curves of the two sowings were nearly identical, only one is shown on the accompanying graph. At 3 1/3 months the seed coats were opening freely.

CONCLUSION: Steady increase in viability indicates that the seed had not passed the culmination of viability at the time of last test. The moderate percentage viable at time of last test suggests that the seed was either of rather poor quality or still insufficiently after-ripened. Opening of the seed coats does not indicate that the after-ripening is complete. Limited oxygen at the bottom of deep containers of stratified seed did not retard after-ripening. (This may not apply to seed stratified in sand as the water drains down in sand to make it soggy at the bottom.)

Effect of ripeness of fruit, upon viability of seed.

DATA: Plums from the same locality, though not from the same bushes, were used for the test. One lot was collected while very green and hard--the membrane surrounding the embryo being still white to light tan; and upon holding in storage fruits shriveled without softening or turning pink. A second lot was collected when fully ripe and allowed to lie in a shallow pile until very rotten and sour. The third lot for a control was fresh ripe plums from which the seed was extracted. The extracted seeds were washed, dried, and stratified at after-ripening temperature (35-40°F.) from 9/23/39 until 2/16/40 (about 5 months).

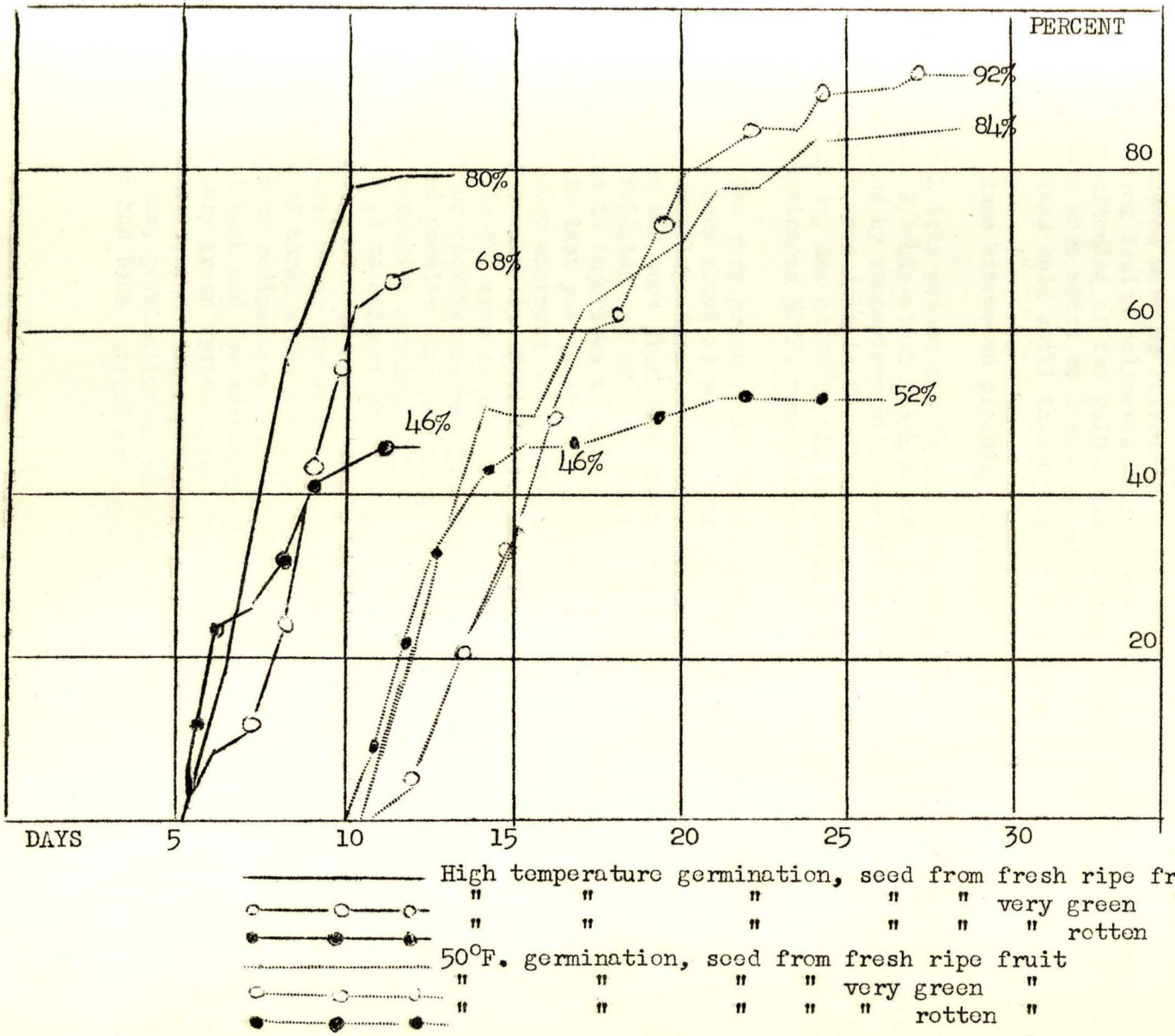
CONCLUSION: The excessively green fruits had seed which germinated as well as that from ripe fruit. Rotting to the point of becoming very sour destroyed most of the seed. Aside from the mechanical difficulties in macerating green plums, it is better to start collections early. This permits use of smaller crews over a longer collection season; permits handling and transportation of plums while they are firm and less susceptible to mashing and heating; permits extraction operations to keep pace with collection. Large quantities of ripe plums awaiting extraction are apt to sour and ruin the seed. Probably a safe rule is to start collection when 50% of the fruits show pink, and the greenest ones show a tinge of tan coming on the membrane enclosing the embryo.



Seed from fresh ripe fruit
" " very green fruit
" " very rotten and soured fruit

AMERICAN PLUM
(Prunus americana)
F-40-12

For description please see next page.



AMERICAN PLUM (Prunus americana) P1-3
F-40-12

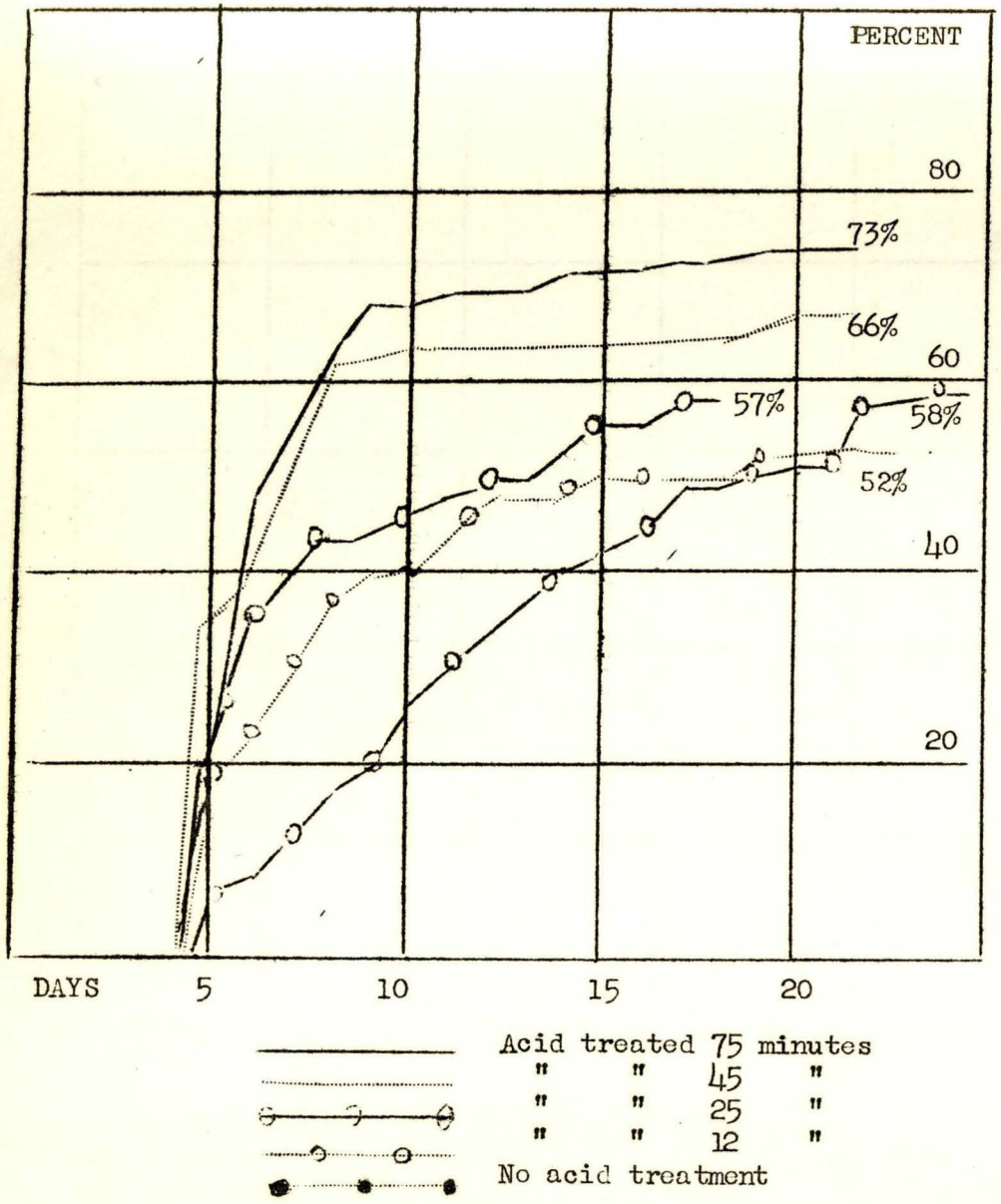
Effects of immaturity of fruit and severe rotting of fruit upon viability of seed. Also shows germination behavior of this seed at high and low temperatures. (Repetition of last year's experiment, to assure that the results were not unduly influenced by variation in source of lots tested, or other factors outside the scope of the experiment.)

DATA: Plums from the same locality, though not from the same bushes were used. The lots tested were as follows:

1. Seed from fruits collected when so green that no reddening of the skins or softening of the pulp occurred upon storage indoors. Inner seed coats were white to light tan color.
2. Ripe plums held until thoroughly rotten. Odor of acetic acid becoming strong.
3. Ripe plums extracted promptly after collection.

Seed of all lots washed and dried, then stratified in moist peat from 9/12/40 until sown 2/6/41--about 4 3/4 months later. After-ripening was complete, as indicated by comparison with results of test made two weeks earlier. Seeds of each lot were sown in two flats, one of which was held at 80°F. for 15 hours each day and at 70°F. the remaining 9 hours. The other flat was carried at continuous 50°F. temperature.

CONCLUSION: The very green fruits contained seed sufficiently developed to germinate and grow about as well as the ripe fruit seed. In the high temperature flat, the seedlings from ripe fruit were 3 to 4" tall on the 12th day after sowing, and the ones from very green fruits averaged about ½" shorter but were well foliated and of good color. Rotting to the point of formation of acetic acid is injurious to the seed. Apparently the injury was not as severe as in last year's similar experiment. On the Prairie States Forestry Project, where enormous quantities of plums are handled, (176,000 lbs. at Norfolk, Nebraska, in 1939) it seems to be a safer practice to start collection while the crop is fairly green. This permits use of smaller crews over a longer picking season, less crushing and heating of the fruit in transit, and permits the extraction operation to keep up with the deliveries and avoid excessive rotting of piles of plums awaiting processing. Probably a safe rule is to collect when the greenest fruits show light tan coloration of the inner seed coat enclosing the embryos. Germination at 50°F. temperature produced later and much slower germination and seedling development. At the end of three weeks after sowing, the sprouts were 1" to 1½" tall with only a tuft of rudimentary leaves at the top. Total germinations were about the same at high and low temperatures for the ripe and rotten lots. The seed from very green fruits, germinated at 50°F. gave highest germination of any of the lots; and considerably higher than for the same lot germinated at 80°F. However, germination of that lot in the warm flat might have continued if the test had been carried longer.

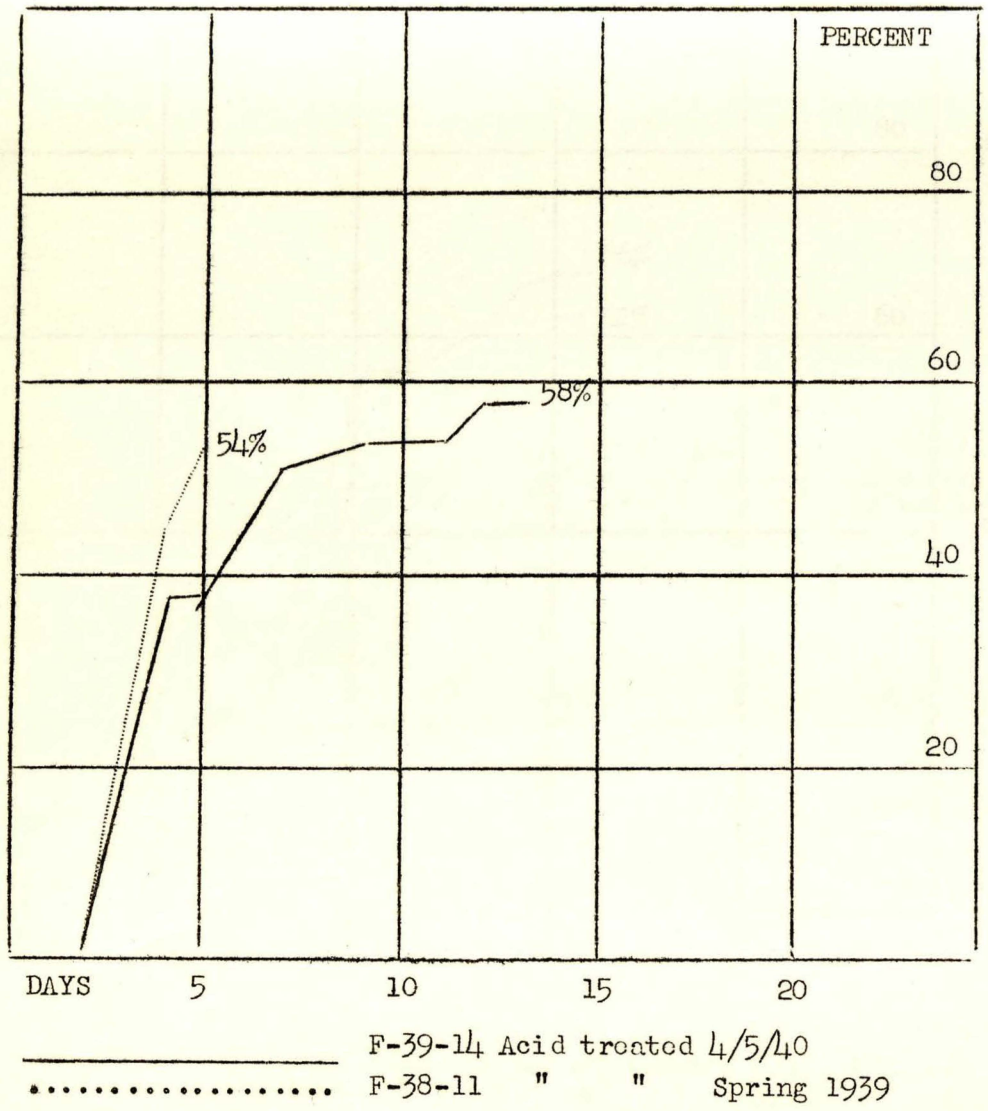


BLACK LOCUST (Robinia pseudoacacia) BL-1
F-36-18

Effect of acid etching upon speed and percentage of germination.

DATA: Random sample of our stores F-36-18 was submerged in H_2SO_4 (without dilution) with occasional stirring. At the end of 12, 25, 45, and 75 minutes, portions were removed and washed thoroughly and then dried. 100 seeds of each lot were sown 12/22/36.

CONCLUSION: Lengthening of the treatment caused a progressive gain in rapid, even emergence as well as in the percentage rendered viable. Quick emergence of all the viable seed should minimize damping off infection as well as give even aged stands with less suppression of the delayed germinations. Longest treatment used may not have been the optimum for this particular lot of seed.

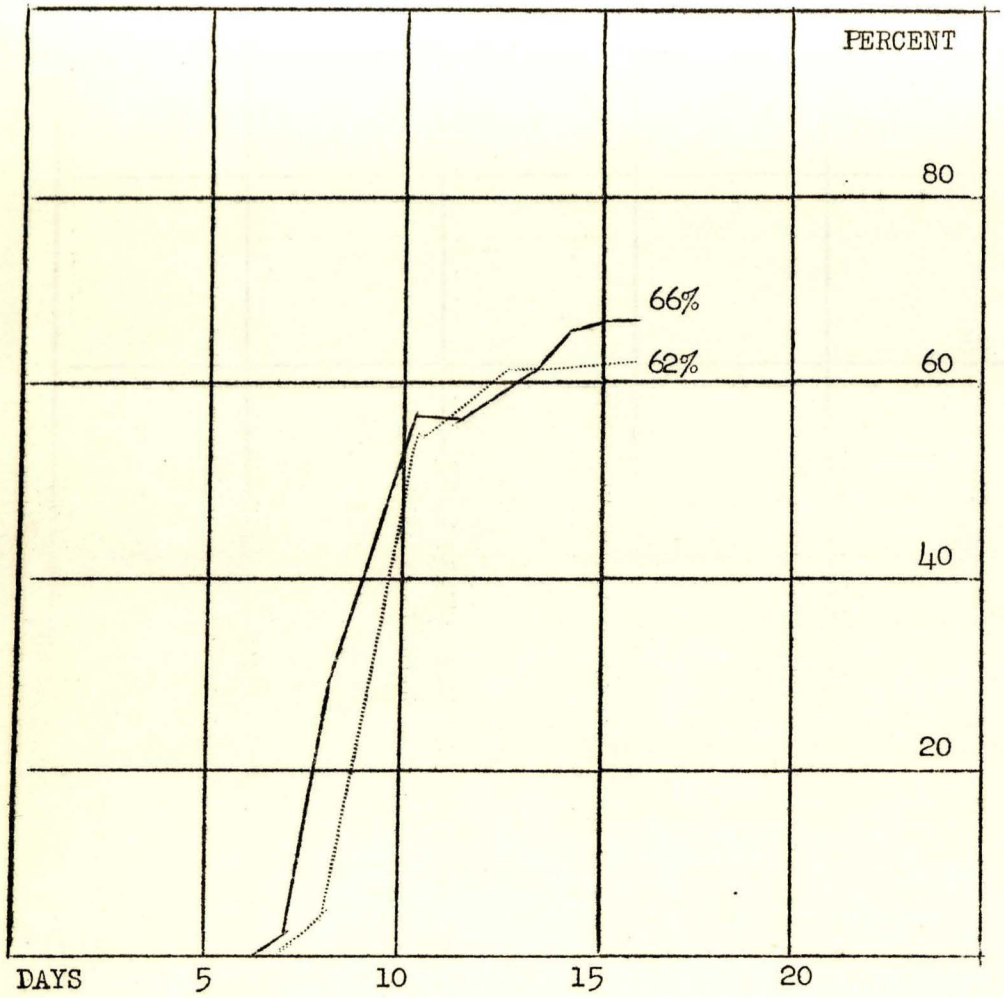


BLACK LOCUST (Robinia pseudoacacia)
F-38-11 and F-39-14 BL-2

Deterioration of acid etched seed stored in closed container at warehouse temperature.

DATA: Seed treated in spring of 1939 by another nurseryman was carried over until the following year in a 10-gallon cream can partly filled. Length of treatment and original viability was not recorded. Seed F-39-14 was treated with H_2SO_4 for 40 minutes, stirring occasionally, then washed and dried. Routine test sowings of the two lots on April 5 and 23, 1940, respectively, gave the results recorded.

CONCLUSION: Apparently the acid treatment did not impair the keeping qualities of the seed, as it was in good condition after 1 year's storage in closed container. While the test was discontinued before completion, the behavior compared favorably with other seed treated just prior to sowing. The test does not purport to show that acid treated seed carried over from year to year in burlap bags keeps equally well. Until further data on this point is available, acid treated seed should be carried over in closed containers.



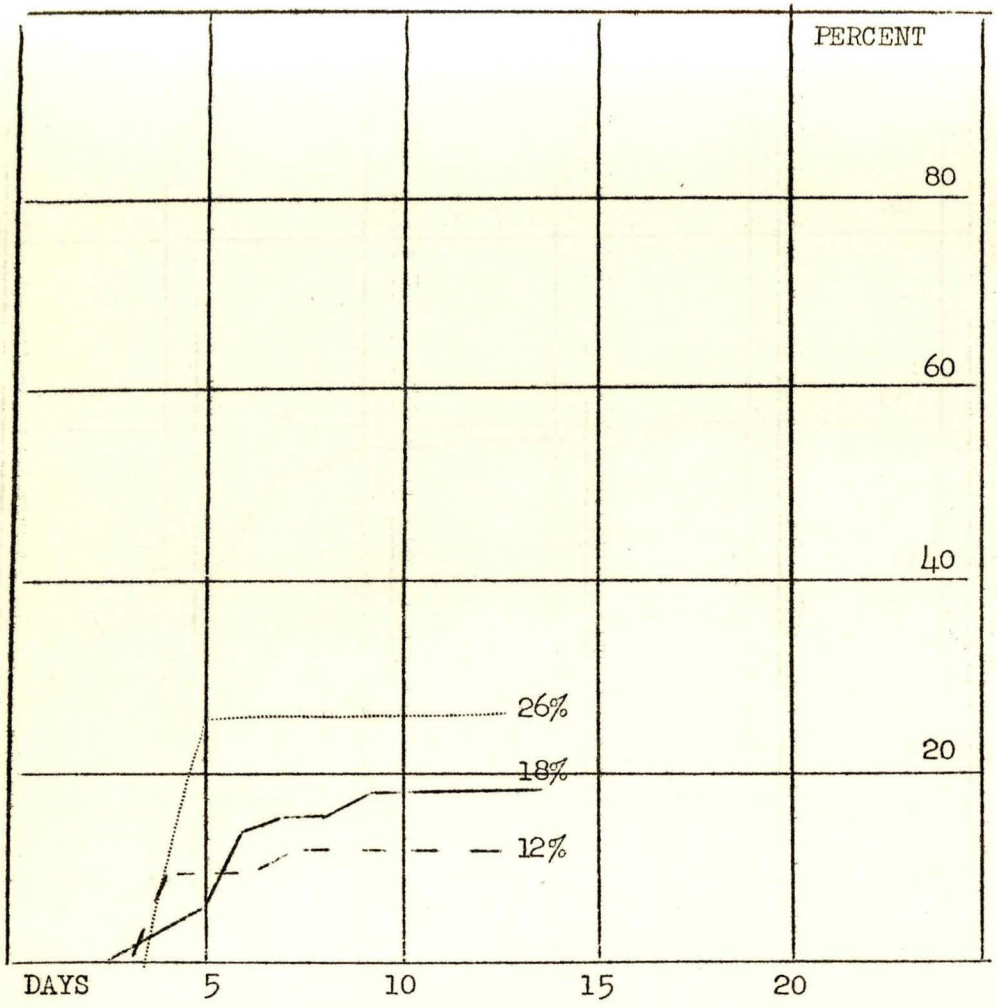
F-39-14 Acid treated 80 minutes 2/12/41
F-40-19 " " 80 " 2/12/41

BLACK LOCUST (Robinia pseudoacacia) BL-3
F-39-14 and F-40-19

Routine test of year-old and current crop.

DATA: Random samples from main stores were treated in H_2SO_4 for 80 minutes at room temperature of about 65°F. on 2/12/41. They were washed thoroughly, dried, and sown a few days later. Germination temperature was 80°F. for 15 hours a day and 70°F. for 9 hours a day. They were sown in sand-peat mixture. The acid treatment caused no pitting or other evidence of excess treatment. Storage was in burlap bags at warehouse temperature.

CONCLUSION: Germination behavior of the two lots was almost identical. F-39-14 germinated in slightly higher percentage following 80 minutes treatment in 1941 than from 40 minutes treatment in 1940 (BL-2). Sealed storage of untreated Black locust is not necessary.



Sown 3/1/40
" 3/27/40
" 3/15/40

BOXELDER (Acer negundo) Bo-1
F-38-22

Routine tests of seed stratified for field sowing.

DATA: Random samples from a 23-lb. lot stratified 1/5/40 and carried at 34-40°F. were sown on March 1, 15, and 27, 1940. Sown in sand-peat mixture and germinated at warm temperature.

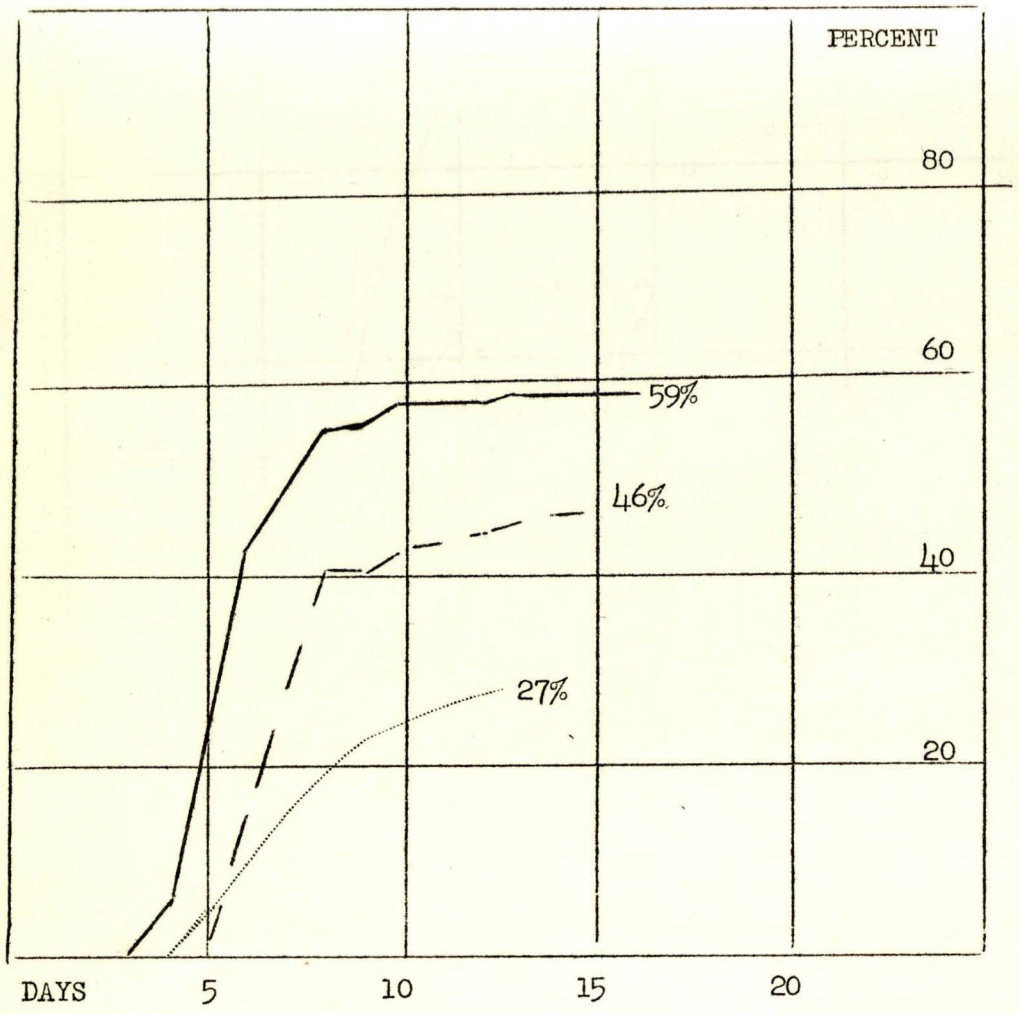
CONCLUSION: The low percentages of germinations indicate probably poor seed, though the testing method may have been ineffective in some respect unknown.

BUFFALOBERRY (Shepherdia argentea) Bu-1
E-36-14

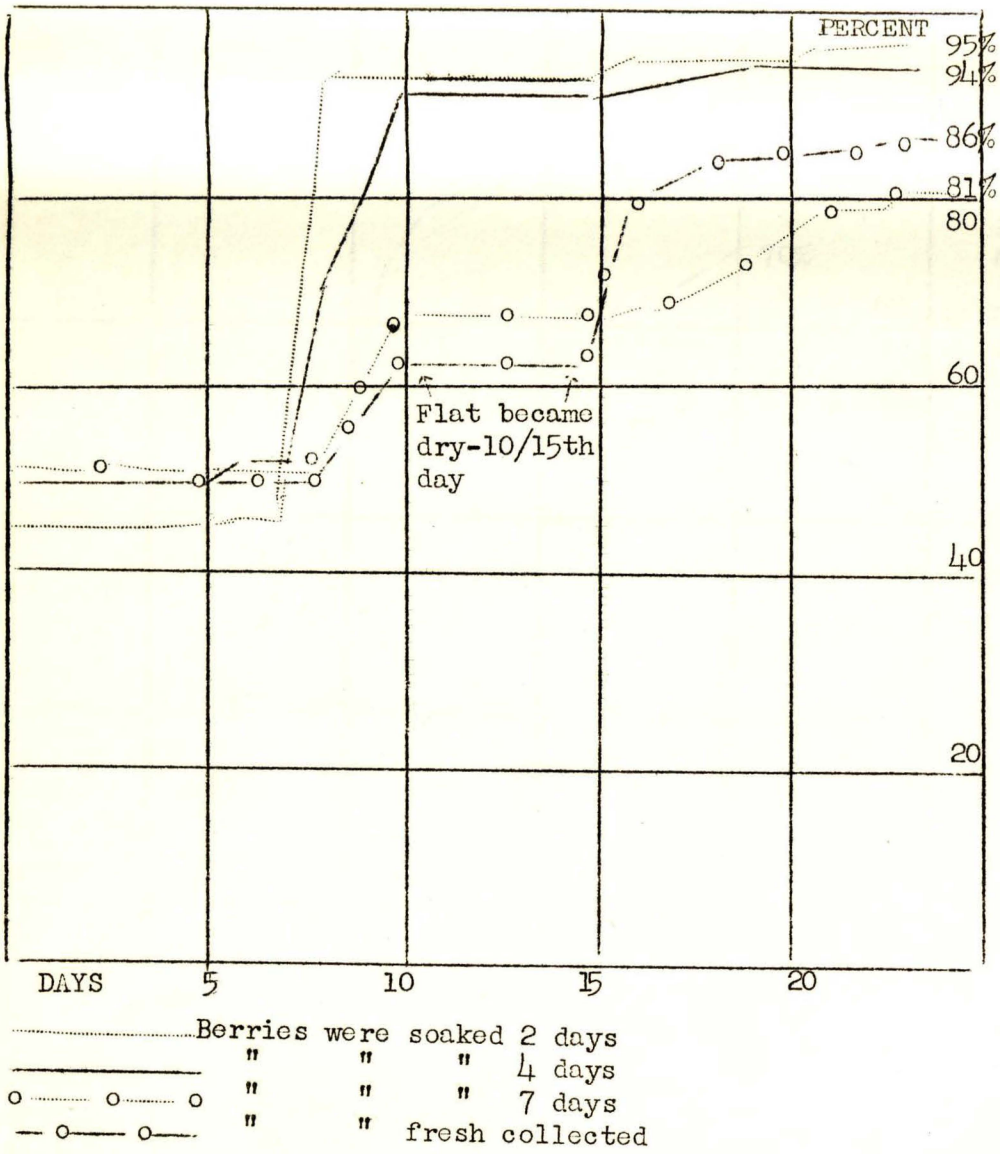
Routine tests of supply at ½ year and 3½ years' storage in burlap bags at room temperature.

DATA: Random samples from 25-lb. lot stratified 1/25/37 for field sowing were sown on 3/20/37 and on 4/12/37. The earlier sowing was in sand held at kitchen temperature; and the latter one in sand held in electric germinator, (probably about 70°F.) Also random sample of main supply was stratified in spring 1940 and sown in sterile sand-peat mixture on 5/7/40. (Record of stratification date lost.)

CONCLUSION: At the end of 3½ years "open" storage, the seed retained about 75% of its initial viability. Some evidence (inconclusive) of 2 months being optimum stratification period for the species.



——— E-36-14 Stratified 1/25/37, sown 3/20/37
..... E-36-14 " 1/25/37, " 4/12/37
— — — E-36-14 " ? " 5/7/40



BUFFALOBERRY (Shepherdia argentea) Bu-2
E-36-14

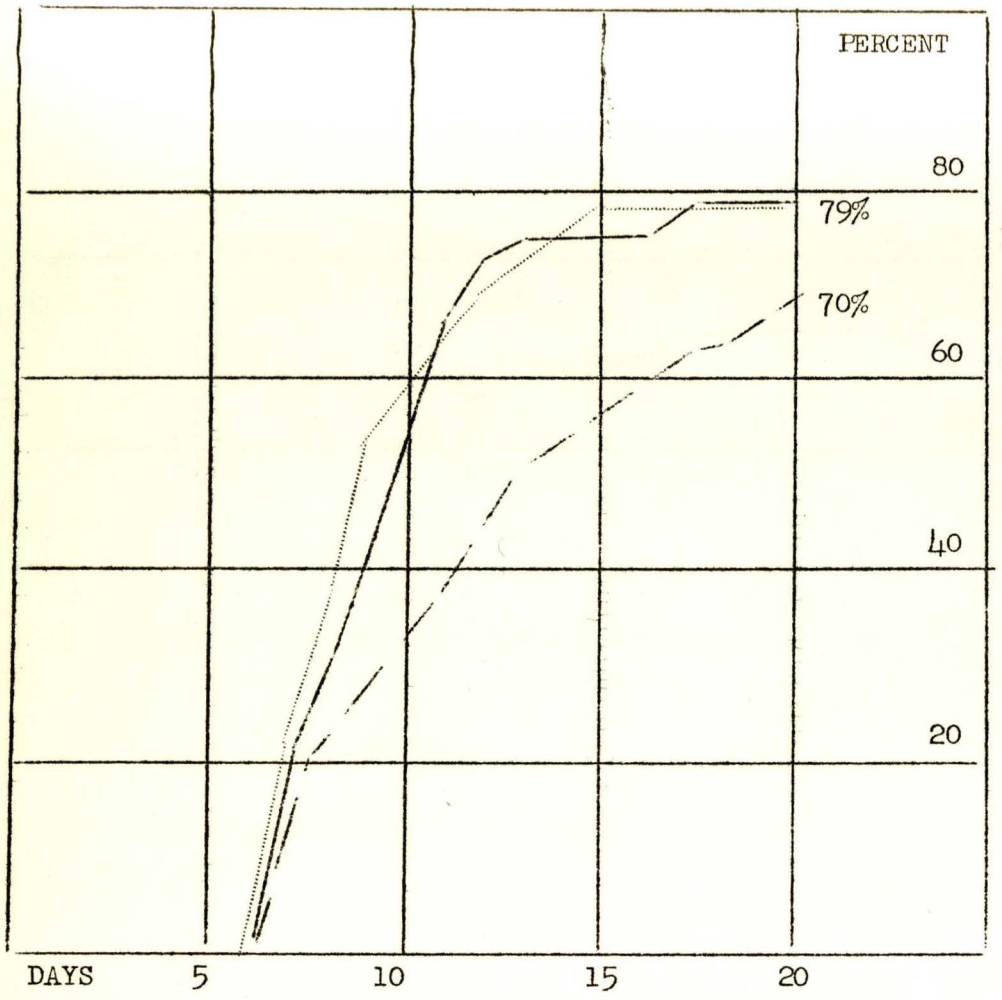
Test of seed stratified shortly after extraction, including berries fermented during extraction.

DATA: A liberal random sample of berries collected was fermented for varying periods from September 20-27, 1936, and the seed from each lot stratified at after-ripening temperature from 10/11/36 to 1/9/37. The lots were as follows:

1. Berries soaked 2 days, fermentation just starting.
2. Berries soaked and fermented 4 days.
3. Berries soaked and fermented 7 days. (sour wine)
4. Control, fresh berries.

The percentages at which the graph lines start are the percentages of the seed which was already sprouted in the stratification medium at the time of sowing.

CONCLUSION: As in numerous tests of other fleshy fruits, moderate amounts of fermentation increase the viability of the seed. Injury begins with formation of vinegar in the juice. Seed stratified shortly after extraction apparently has less germ-dormancy, and germinates in higher total percentages than when the seed is stored dry for 6 months or more.



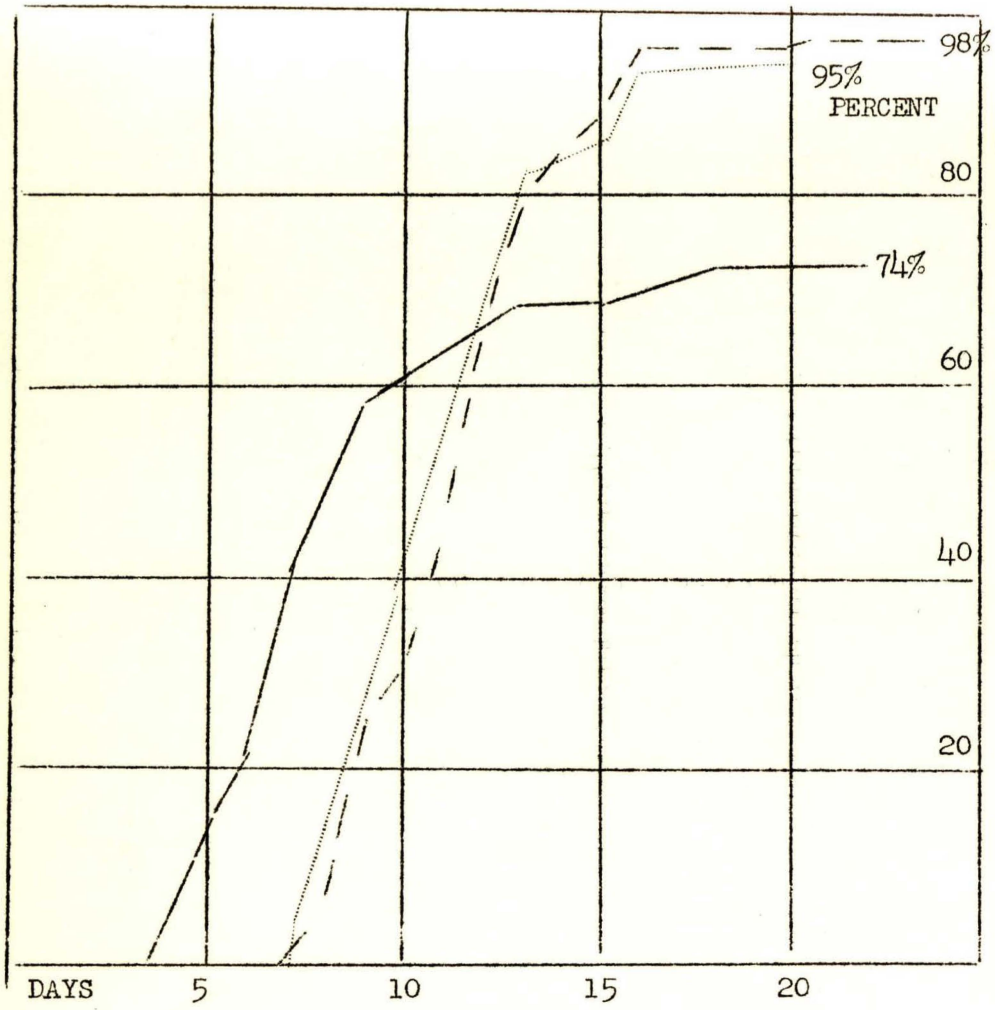
CARAGANA (Caragana arborescens) Car-1
F-38-8, F-39-6, & E-39-11

Routine tests of seed stores.

DATA: Random samples sown 2/8/40, without any pre-sowing treatment. No record kept of germination temperature.

CONCLUSION: All lots show viability suitable for field sowing.

——— F-38-8 Sown 2/8/40
..... F-39-6 " 2/8/40
— — — — E-39-11 " 2/8/40



B-35-53 Sown 3/2/37
F-40-7 " 2/14/41
E-40-10 " 2/14/41

CARAGANA (Caragana arborescens) Car-2
B-35-53, E-40-10, & F-40-7

Routine tests of seed stores.

DATA: Random sample of B-35-53 was sown dry 3/2/37. Random samples of E-40-10 and F-40-7 were sown as dry seed in moist sand-peat mixture and germinated at temperatures of 80°F. for 15 hours a day and 70°F. the remainder.

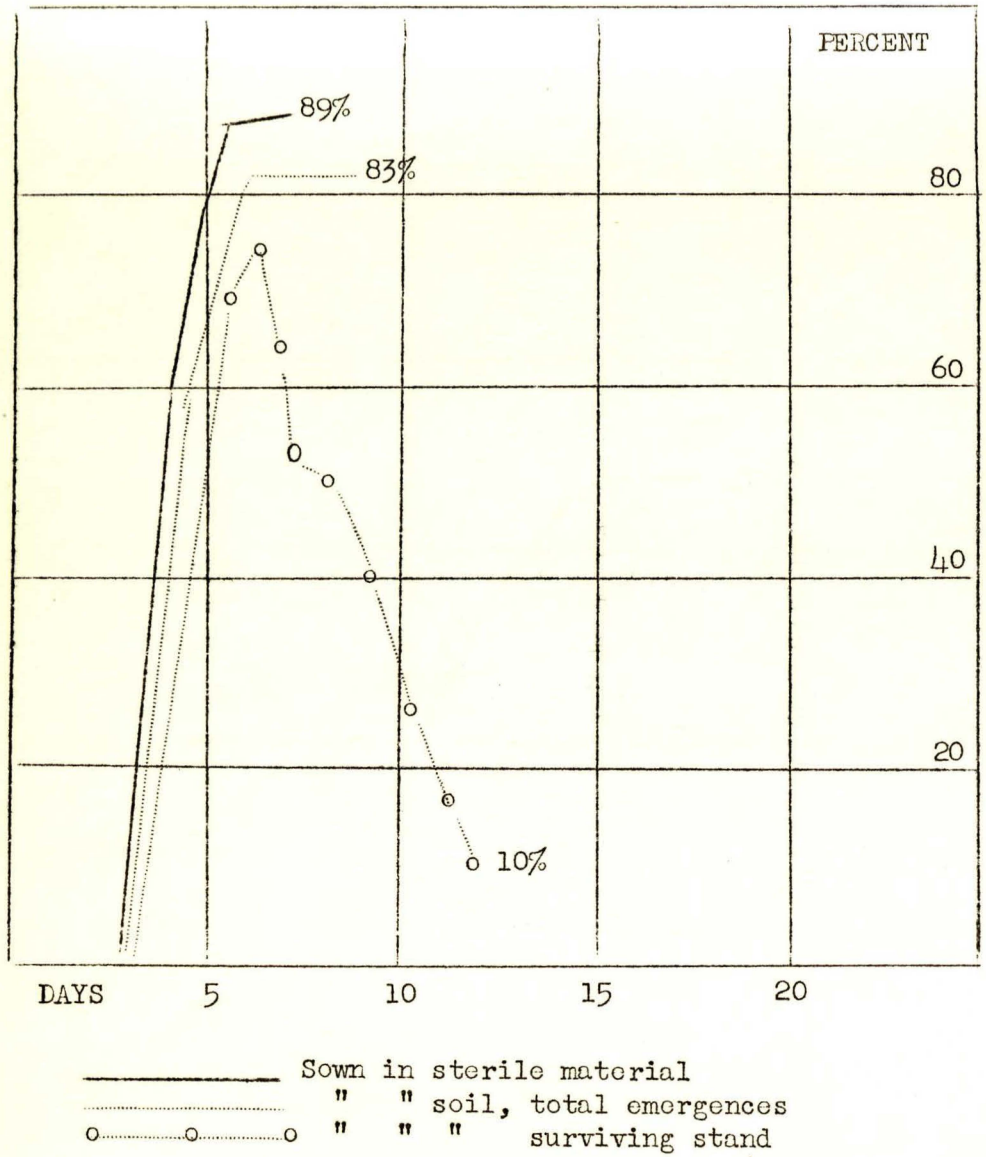
CONCLUSION: All lots show good viability. The seed germinates best at high temperature.

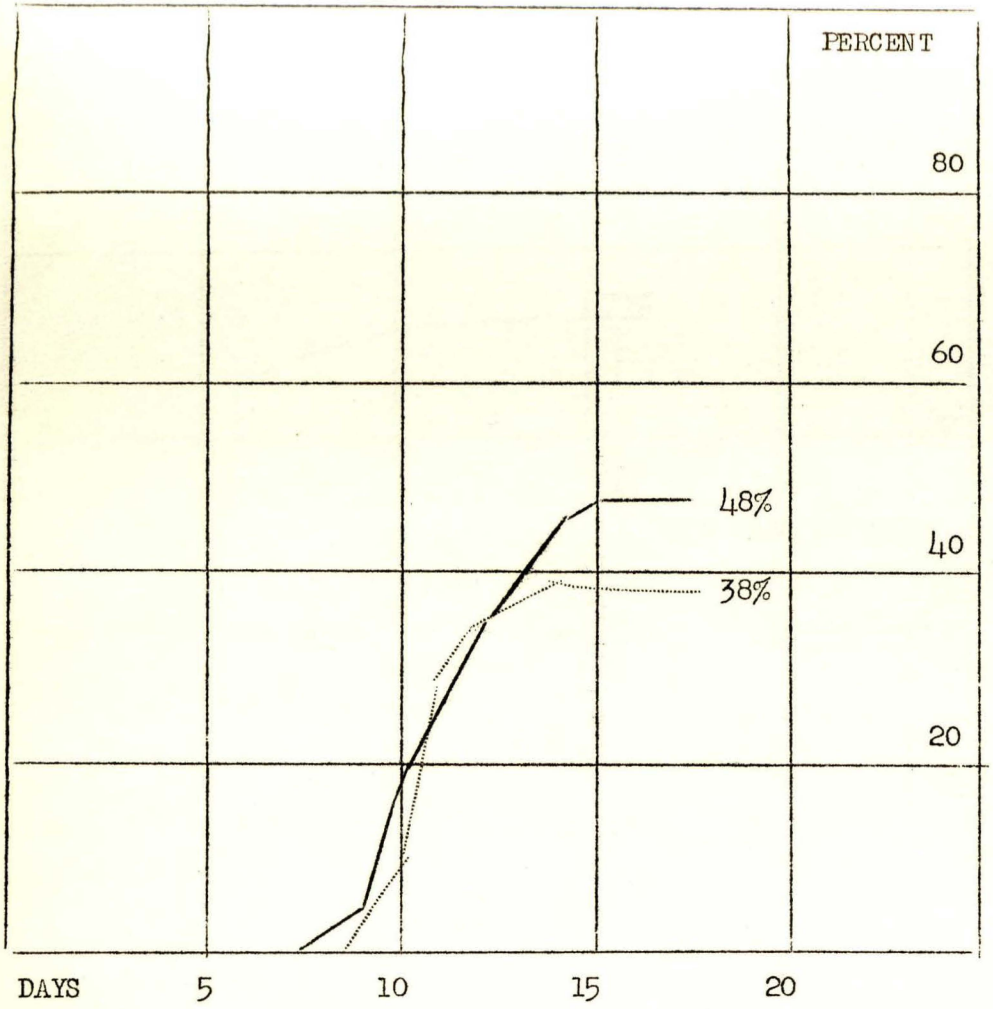
CHINESE ELM (Ulmus pumila) Chi-2
F-39-2

Damping-off of Chinese elm sown in soil from Norfolk Nursery. Routine test of stores.

DATA: Random sample from supply was divided and 100 seeds of each lot sown in nursery soil and in sand-peat mixture which had been sterilized by boiling. Storage from June 1939 to time of sowing, 5/7/40, was in tightly closed full container, held at 35-40°F. The seed was sown dry.

CONCLUSION: Damping-off losses up to 100% may be expected if weather conditions at time of emergence are favorable to the disease. The seed as stored retained most of its initial viability.





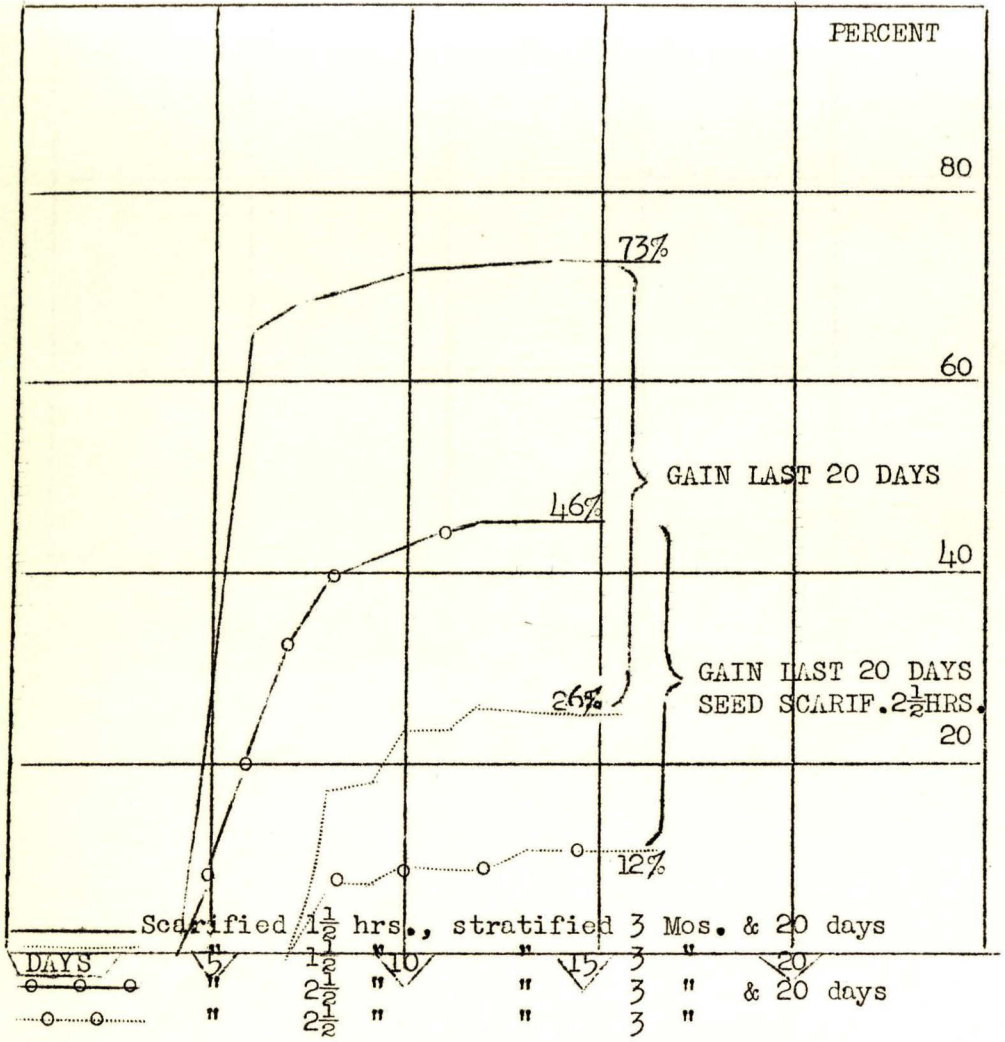
Sown 2/23/38, stratified 12/18/37
" 3/14/38, " 12/18/37

CHINESE TREE LILAC (Syringa japonica) Ch L-1
F-37-15

Routine test of stratified seed.

DATA: Random sample of seed stratified in peat at 35-41°F. on 12/18/37 was sown on 2/23/38 and on 3/14/38.

CONCLUSION: Two months, or possibly less, is sufficient for after-ripening of this species; though the limited number of tests and only fair germinations obtained leaves the question open to further evidence.

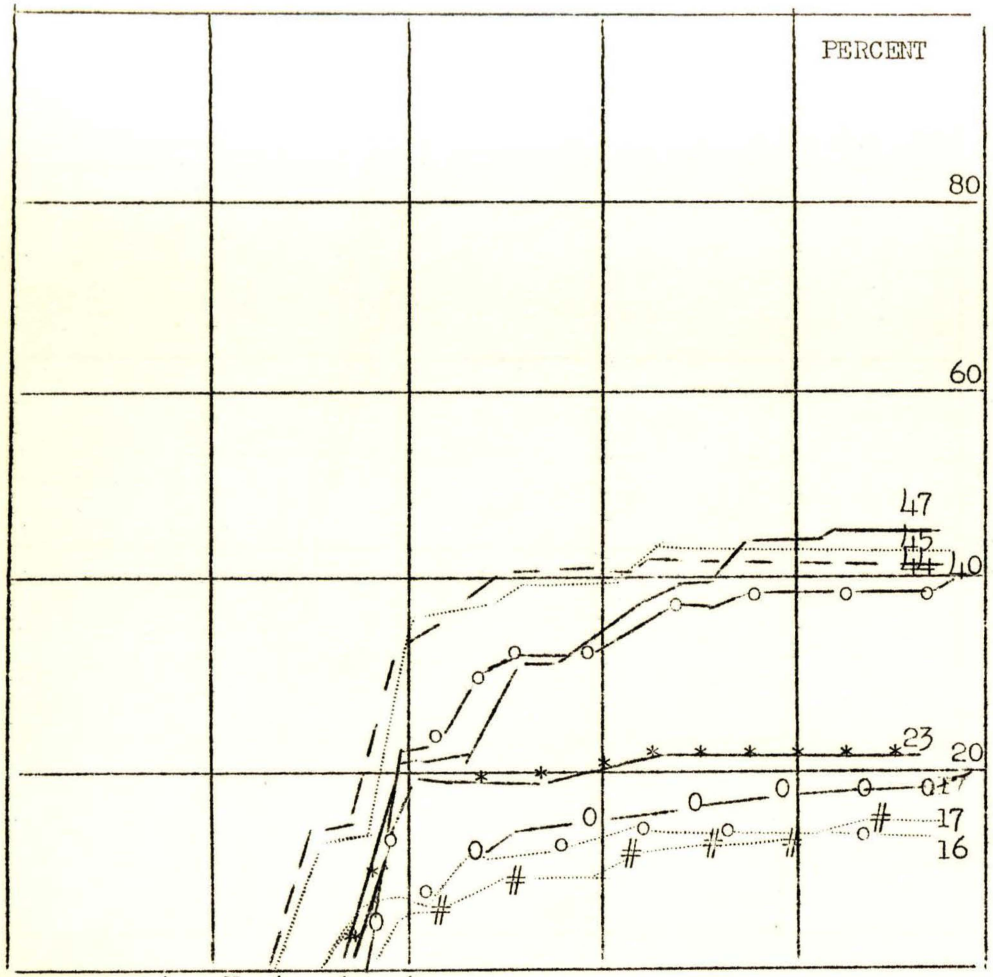


EASTERN REDCEDAR (Juniperus virginiana) Ce-1
F-36-29

Routine tests show rapid culmination of viability toward end of after-ripening period.

DATA: Random samples of our main stores which had been scarified for 1½ hours and 2½ hours, respectively, in Denbeigh type scarifier just prior to stratification, were tested after 3 months and 3 months plus 20 days. The first sowing was germinated in a rather warm place near a furnace, and the second test in our electric germinator at somewhat comparable temperatures. Possibility of the difference in results being due to the difference in germination environment is largely discounted by similar showing in other years, though lower series of percentages were attained.

CONCLUSION: Viability increased three-fold or more during the last 20 days following 3 months prior stratification at after-ripening temperature. Scarification for the longer period gave poorest results. (See Ce-2, where seed not scarified gave higher germinations than seed scarified for any of the periods used.)



A. No treatment
B. Scarified 1½ Hrs.
C. " 2½ "
L½ Lye trtd. then scar. ½ hr.
L-1 " " " " 1 "
L-1½ " " " " 1½ "
CL Concentrated lye
N Naptha

3/22/37
Sown at
3 months
stratification.

EASTERN REDCEDAR (Juniperus virginiana) Ce-2
F-36-29

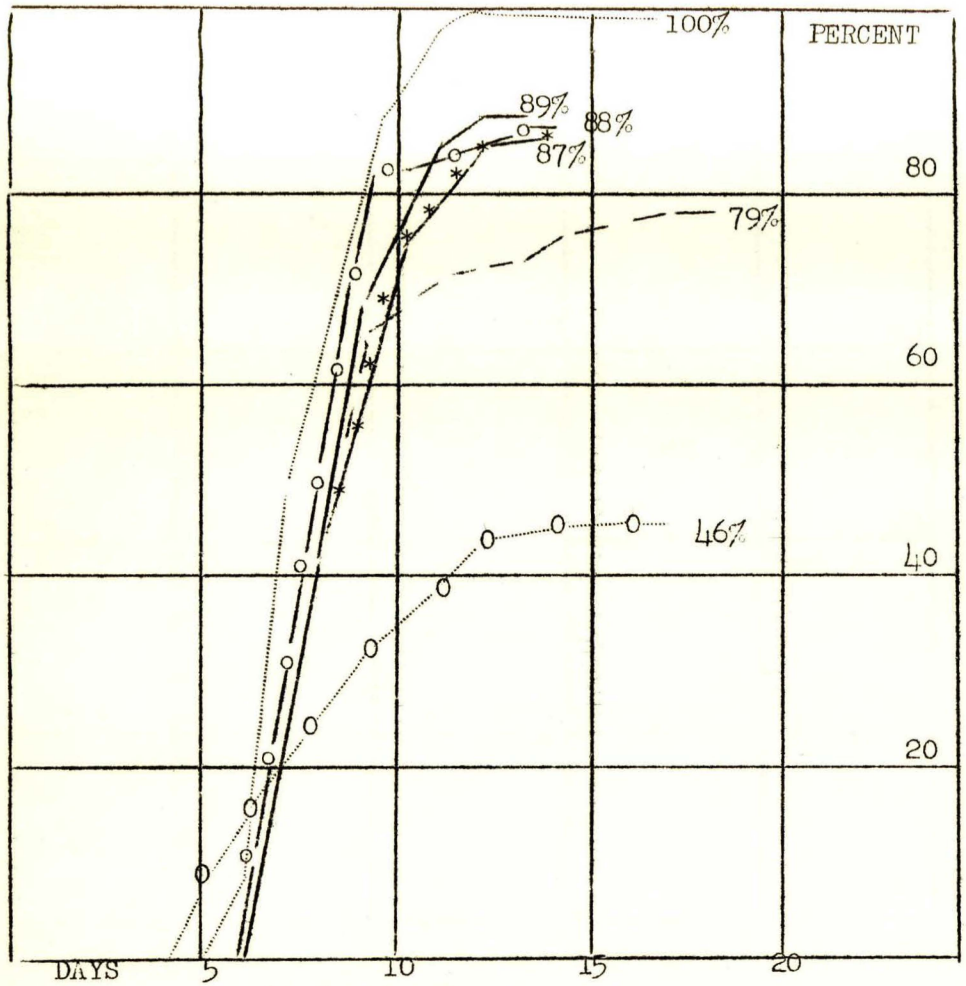
Various periods of scarification and chemical treatment prior to various periods of stratification at after-ripening temperature.

DATA: Portions of seed were treated as follows:

A Control, no treatment.
B Scarified in Denbeigh type scarifier, 1½ hrs.
C " " " " " 2½ hrs.
L½ Soaked 24 hrs. in solution of 2 teaspoonfuls Lewis lye per gal. water, dried, then scarified ½ hr.
L-1 Same lye treatment, then scarified 1 hr.
L-1½ " " " " " 1½ hrs.
CL Soaked 1 hr. in very concentrated solution of lye.
N Agitated in naptha as a possible solvent of the seed-coat wax.

Berries had been soaked in lye water for seed extraction and empty seed floated out before treatments. Another trial of treating some of this seed with H_2SO_4 for 10, 20, and 30 minutes before stratifying gave rather inconclusive results. All the treated lots germinated in a range of 55-61% at 2 months stratification, and to the same percentages at 3 months stratification. The untreated seed germinated 47% at 2 months, and 75% at 3 months stratification. Apparently the acid treatment shortened the required after-ripening period to 2 months or less, but injured some of the seed. All lots were stratified in moist peat at 35-40°F. on 12/24/36.

Continued on Ce-2a



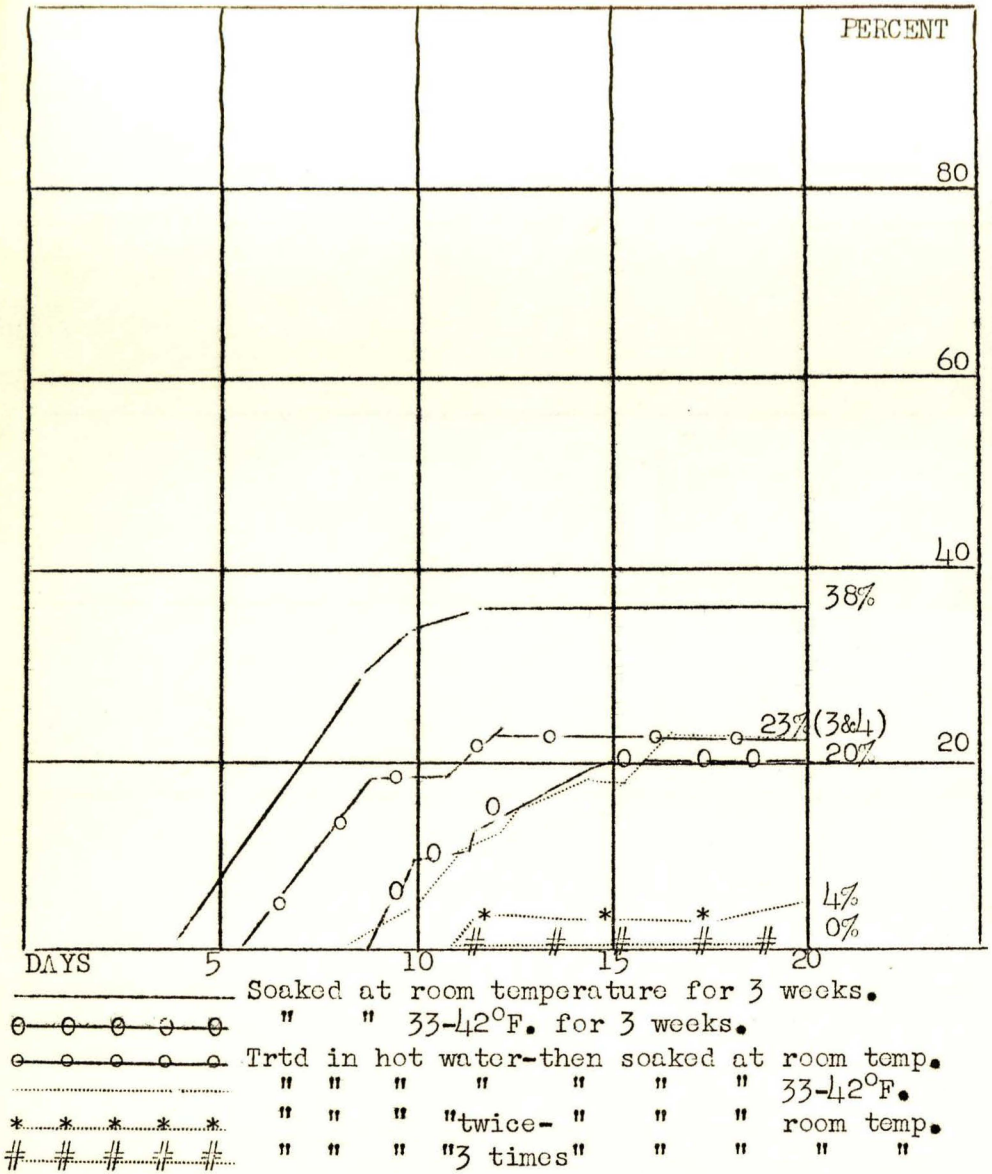
EASTERN REDCEDAR (Juniperus virginiana) Ce-2a
F-36-29

Sowings with resulting germinations were:

Lots	Sown 1/31/37	2/24/37	3/22/37	4/12/37
A	2%	23%	47%	90%
B	3	30	40	88
C	2	15	23	87
L½	4	34	45	100
L-1	0	34	44	79
L-1½	0	15	16	46
CL	0	11	17	*
N	0	5	20	*

* indicates no sowing made.

CONCLUSION: Mechanical high speed scarification of this seed was unnecessary and somewhat harmful, particularly seed softened by the lye treatment. Soaking the clean seed in lye solution is beneficial for securing faster and more complete after-ripening. Viability of all lots was more than doubled during the last 3 weeks of the stratification period.



GREEN ASH (Fraxinus pennsylvanica lanceolata) As-1
F-38-18

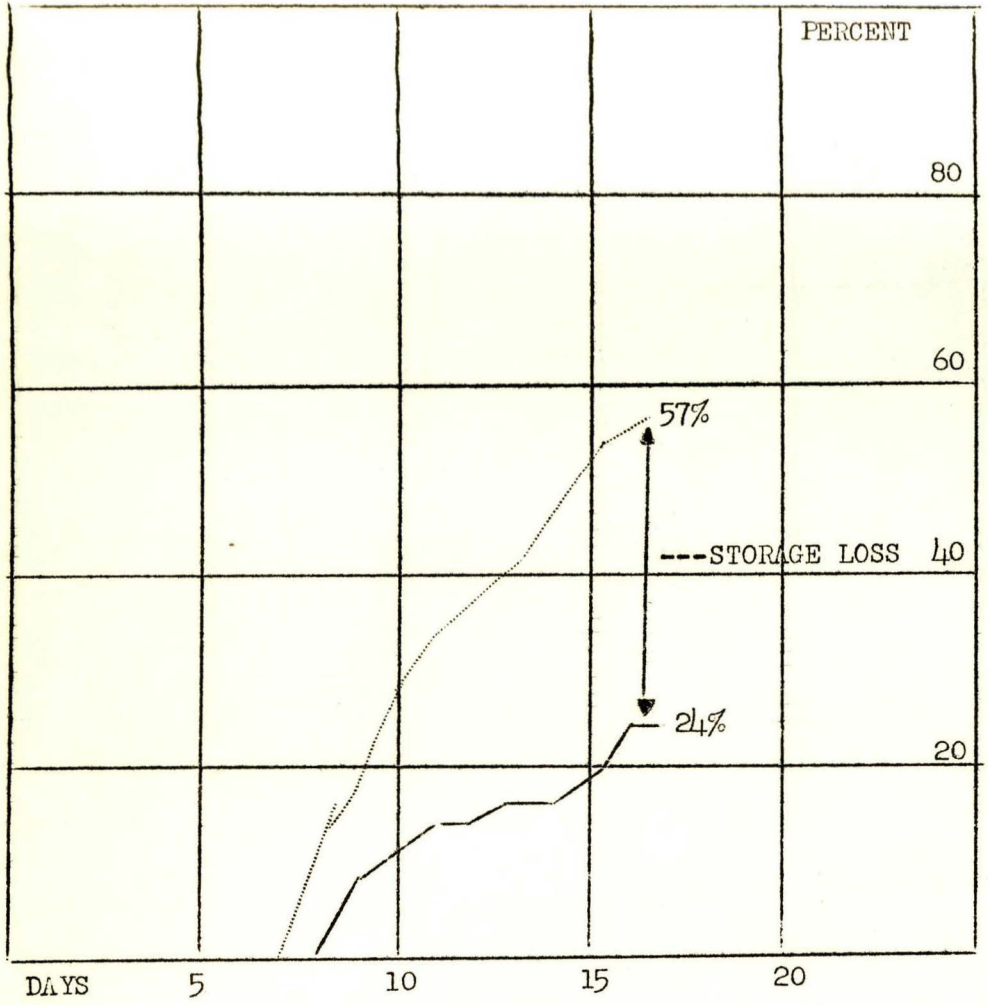
Various treatments exploring the possibility of obtaining better germination of 1½ year old Ash seed.

DATA: Our supply of Ash seed collected in 1938 germinated only 22% when tested in spring of 1940 after soaking for 3 weeks at near freezing temperature, and 0% from seed stratified 5 weeks. Therefore, the following treatments were tried in the hope of stimulating greater viability.

1. Soaking at room temperature for 3 weeks.
2. Soaking at 33 to 42°F. for 3 weeks.
3. Plunged in water 150°F. then soaked at room tem.
4. " as in (3)but soaked at 33-42°F. for 3 weeks.
5. " " (3) twice at daily interval then soaked at room temperature for 3 weeks.
6. " " (3) three treatments then soaked as in 5.

Each of the above lots were germinated at 90°F. and at room temperature. The graph shows only the 90°F. germinations which were more rapid and with a couple of exceptions somewhat higher percentages. The high temperature germination caused faster deterioration of the seed injured by the hot water. Sowing date was 5/26/40.

CONCLUSION: None of the treatments were better than soaking at room temperature for 3 weeks. Poor viability of the seed is indicated, though some of this supply field sown the previous Fall gave a stand high in ratio to the sowing rate. Either the seed deteriorated over winter in dry storage, which is unlikely, or wintering in the ground accomplished some process not fully understood or covered by any of the treatments. Hot water treatment is injurious, the first treatment killing about 50% and the 3rd treatment all of it. 90°F. is a more favorable germination temperature.



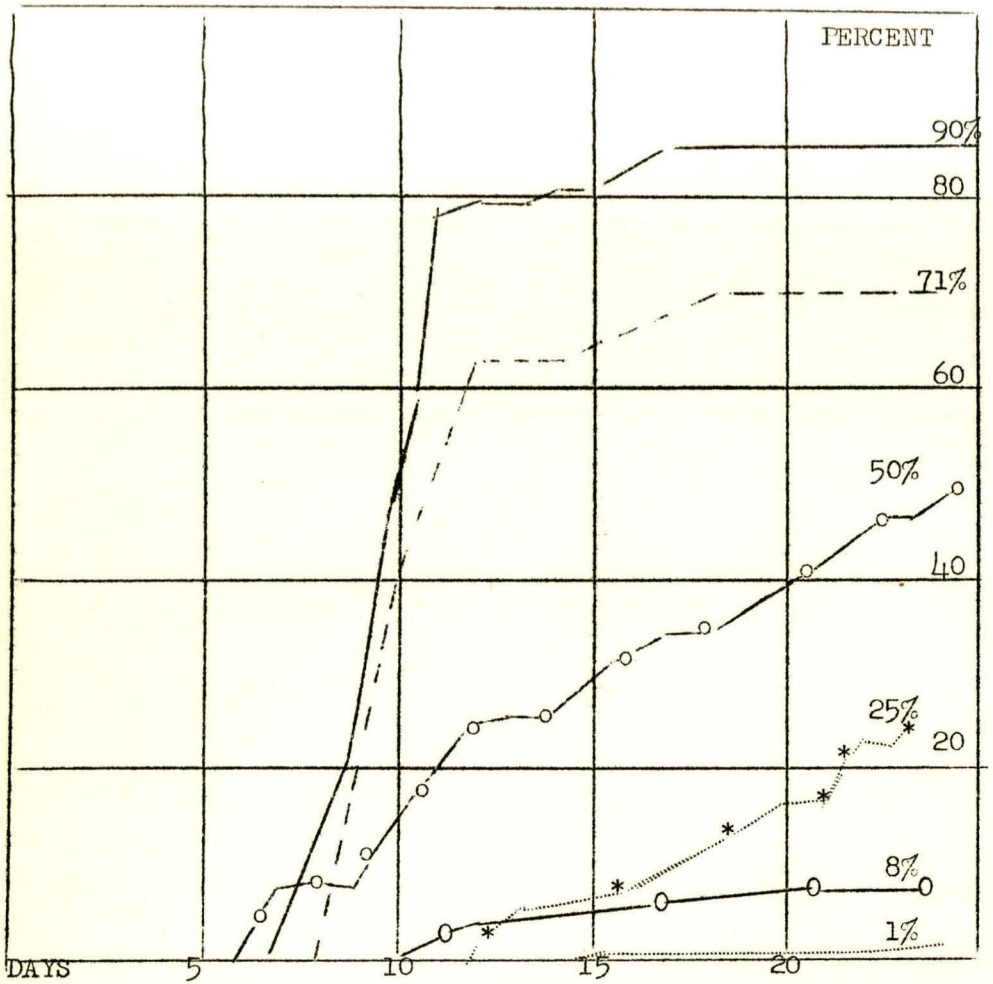
F-37-18 Stratified 5 weeks 3/15/40
F-37-18 Soaked 3 weeks, sown 3/15/38

GREEN ASH (Fraxinus pennsylvanica lanceolata) As-2
F-37-18 et al.

Routine test of stores $2\frac{1}{2}$ years after collection. Viability loss of various lots after 1 year's storage.

DATA: Random sample of seed stratified 2/7/40 was sown 3/15/40. Initial viability is indicated by test 3/15/38 of random sample soaked for 3 weeks. Other lots tested 3/15/38 showed the following results: F-35-7 1%
E-35-9 0%
E-36-25 5%

CONCLUSION: Seed is of too low viability to yield good stand from field sowing the ensuing spring. The other lots tested confirm the evidence in (As-1) that Ash seed stored in sacks at warehouse temperatures suffers serious loss of viability by the end of $1\frac{1}{2}$ year's storage.



GREEN ASH (Fraxinus pennsylvanica lanceolata) As-3
F-36-23 & B-34-1

Shows benefits of prolonged soaking or stratification. Also low viability of seed stored in sacks at warehouse temperatures for $2\frac{1}{2}$ years.

DATA: Aggregate random samples of each of the above lots were divided for treatment by soaking for 3 weeks, and by stratifying at 35-40°F. for 33 days. Water was changed daily on the soaking seed. A few weeks later, other samples were tested after only 1 and 7 days' soaking, respectively. Sowing date of seed having been soaked 3 weeks and that stratified was 2/22/37. Seed soaked 1 and 7 days was sown 3/12/37.

CONCLUSION: Prolonged soaking more than tripled the germination percentage, with corresponding increase in speed of germination. Three weeks soaking was somewhat more effective than 33 days stratification. The $2\frac{1}{2}$ year old seed was too low in viability for successful field sowing.

HACKBERRY (Celtis occidentalis) Ha-1
F-36-26

Effects of depulping and fermenting upon the rate of after-ripening.

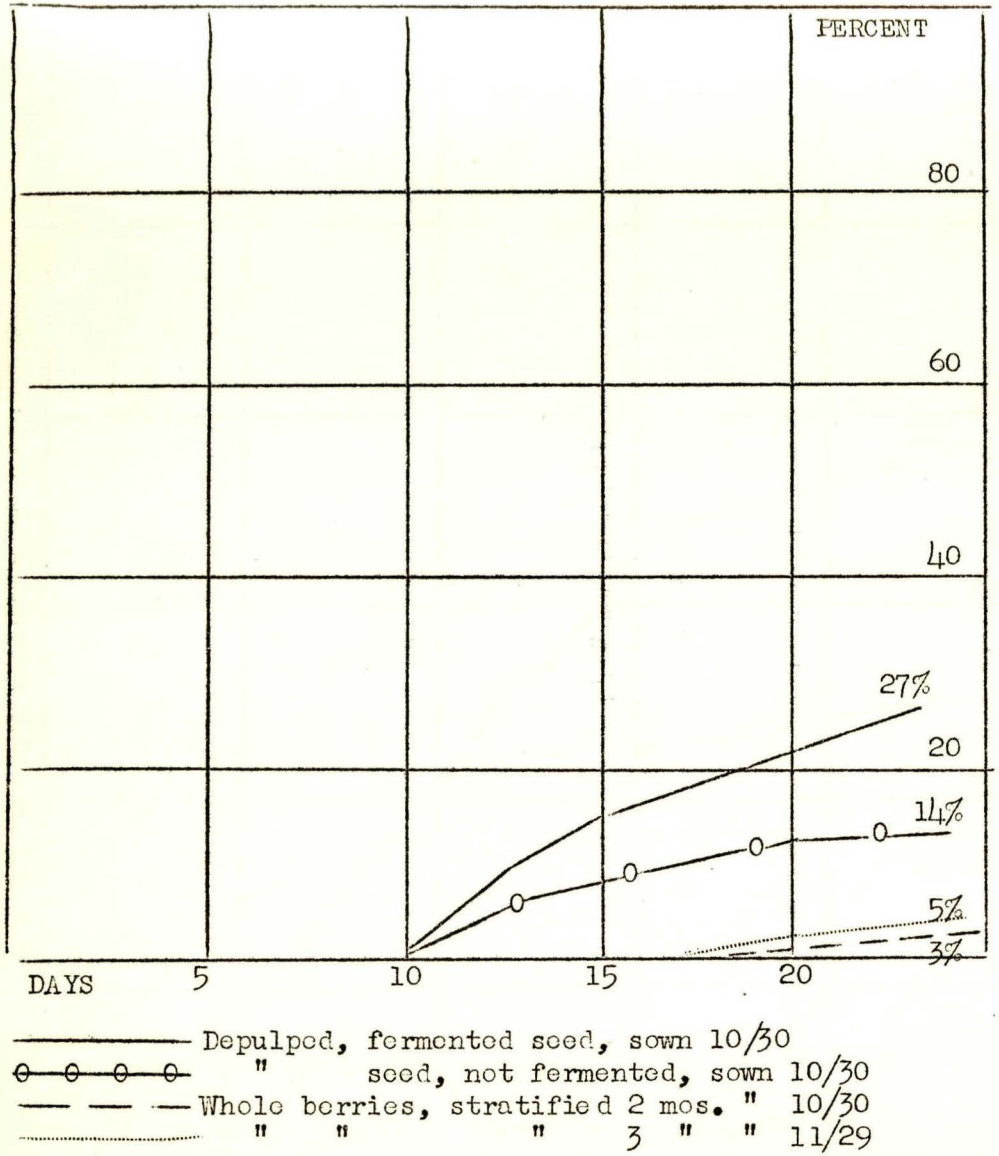
DATA: A sample of Hackberries, F-36-26, was divided and the portions given the following treatments:

1. No treatment, whole berries were stratified.
2. Seed was depulped & washed, then stratified.
3. Seed was depulped & allowed to ferment in the macerated pulp for 3 days, then stratified.
4. Depulped, fermented 9 days, then stratified.

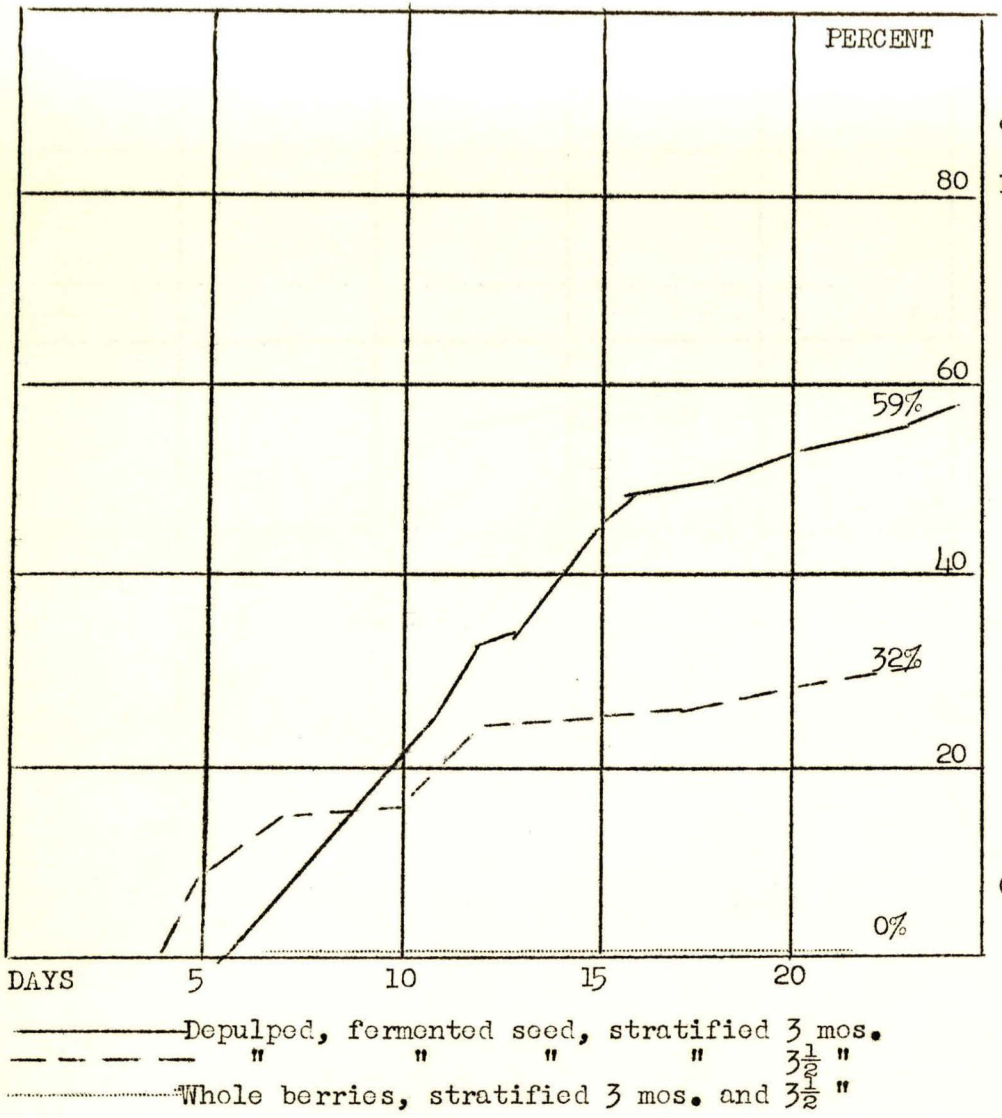
The fermented pulp was washed out from seed lots 3 and 4 before stratifying.

Stratification was at after-ripening temperature from 8/26-10/30/37.

CONCLUSION: Whole Hackberries after-ripen to only a negligible degree during the period required for complete after-ripening of depulped and fermented seed. (This factor varies from year to year, possibly with the concentration of sugars, but is very noticeable in all crops tested.) Fermentation for a few days prior to stratification of the depulped seed, accelerates the after-ripening process.



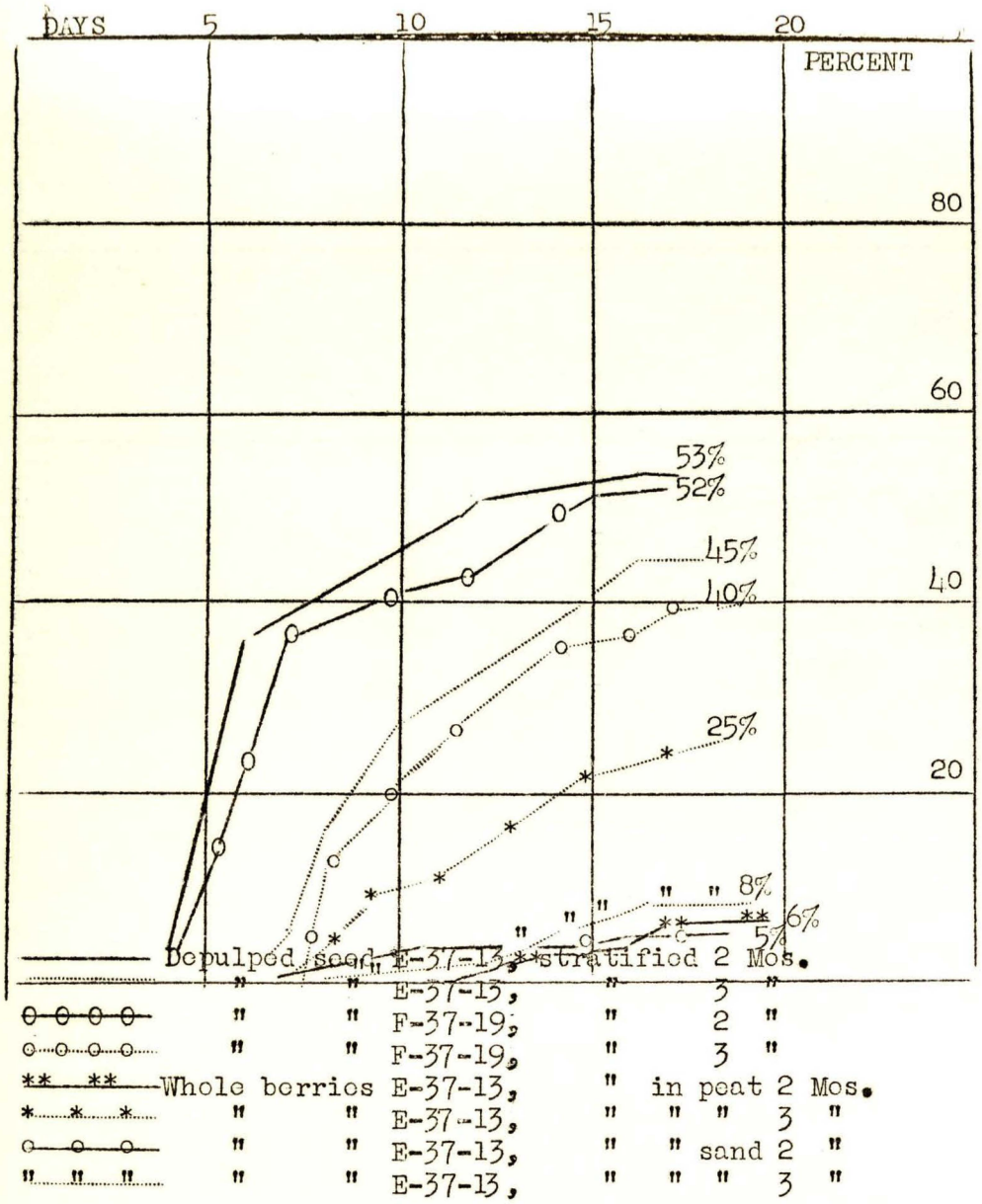
HACKBERRY (Celtis occidentalis) Ha-2
F-36-26



Routine tests of main stores confirm effects of depulping and fermenting Hackberry seed.

DATA: 800 lbs. of whole Hackberries and 756 lbs. of depulped Hackberries were stratified in moist sand 12/26-29/36. The depulped seed was spread on a concrete floor to drain off surplus water before stratifying. Room temperature was around 50-60°F. and after a couple of days, fermentation set in and the seed got quite warm. The seed was mixed with cold damp sand and put in the cooler. A week or two later this stratified seed again became noticeably warmer than the air, so it was transferred to a room where the temperature was a little below freezing. When the heating had disappeared, the temperature of this room was allowed to run a few degrees above freezing for the remainder of the period. The whole berries showed no tendency to heat; and at the end of the stratification period, were bright and of the same general appearance as at the beginning of stratification. Germination test sowings were made of each lot on 3/20 and 3/31.

CONCLUSION: The depulped and fermented seed after-ripened well in 3 months, but in the whole berries practically no after-ripening had occurred.



HACKBERRY (Celtis occidentalis) Ha-3
E-37-13 & F-37-19

Routine tests of whole berries and depulped seed.

DATA: 164 lbs. of Hackberries E-37-13, and 1115 lbs. of F-37-19 were depulped and stratified in moist sand 12/16/37. No record was kept of the amount of fermentation occuring before stratifying, but it was regular procedure to hold the depulped seed at room temperature without drying out, until depulping of the lot was completed. A 2-bushel box was filled with whole berries E-37-13 mixed with moist sand, and another with berries and moist peat. All lots were carried at after-ripening temperature of 35-40°F. in the same room. Sowing tests of all lots were made 2/23/38 and 3/14/38.

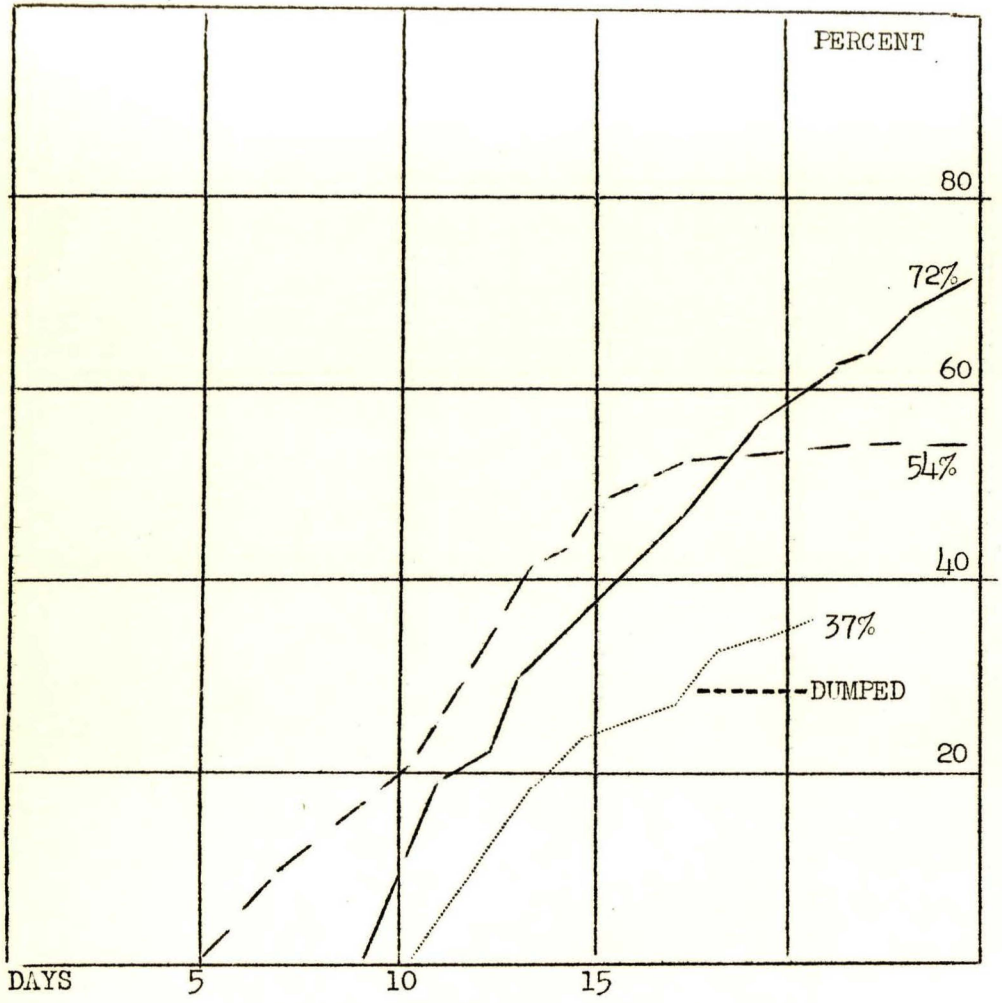
CONCLUSION: The depulped (and probably fermented) seed germinated well after two months stratification and had passed its prime by the third month, at which time the whole berries were just beginning to after-ripen. Whole berries stratified in peat after-ripened a little earlier or faster than the whole berries in sand.

HACKBERRY (Celtis occidentalis) Ha-4
E-36-17

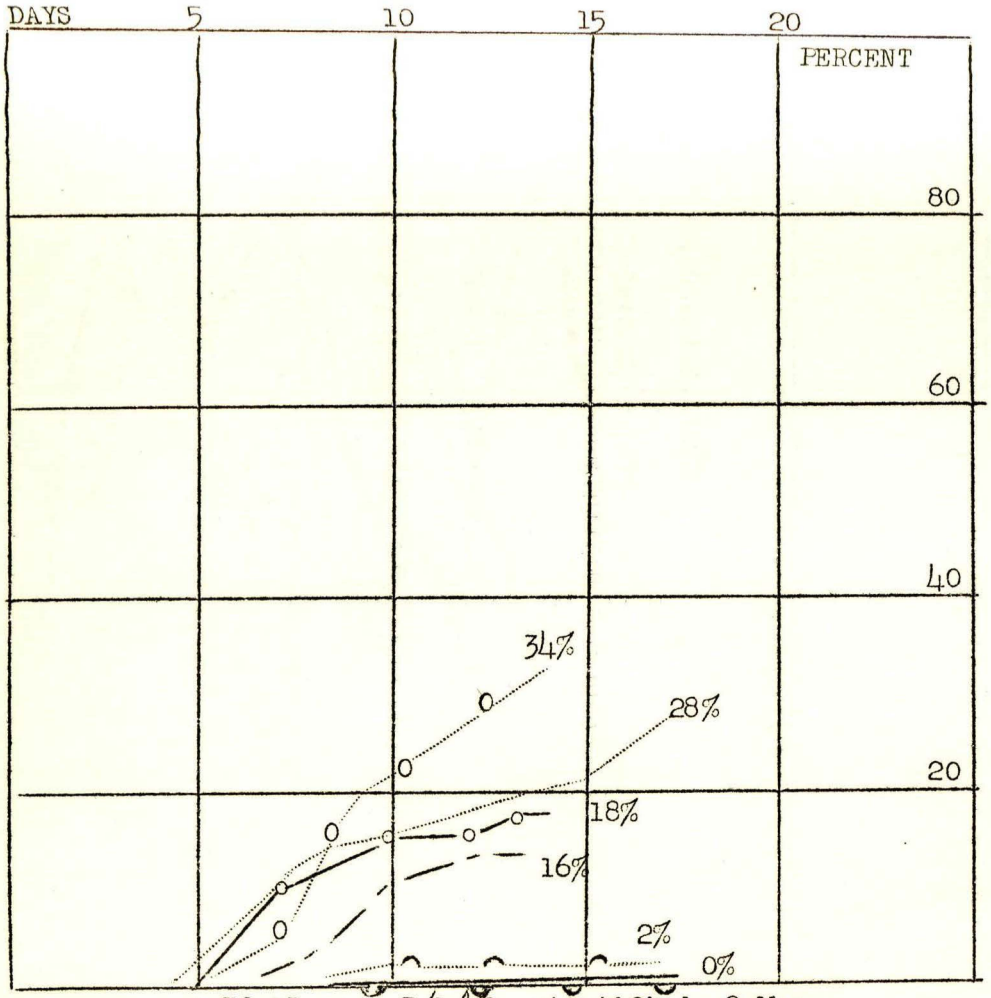
Routine tests of depulped Hackberry seed.

DATA: 1650 lbs. of berries were depulped 12/23/36 and stratified in sand. Fermentation history is similar to F-36-26 described in Ha-2. Sowing tests were made of random samples taken after 2, 3, and 3½ months of stratification.

CONCLUSION: Viability of this depulped and fermented seed was 73% at two months stratification, and lower at 3 and 3½ months.



Depulped seed, stratified 2 Mos.
" " " 2 3/4 Mos.
" " " 3 1/2 "

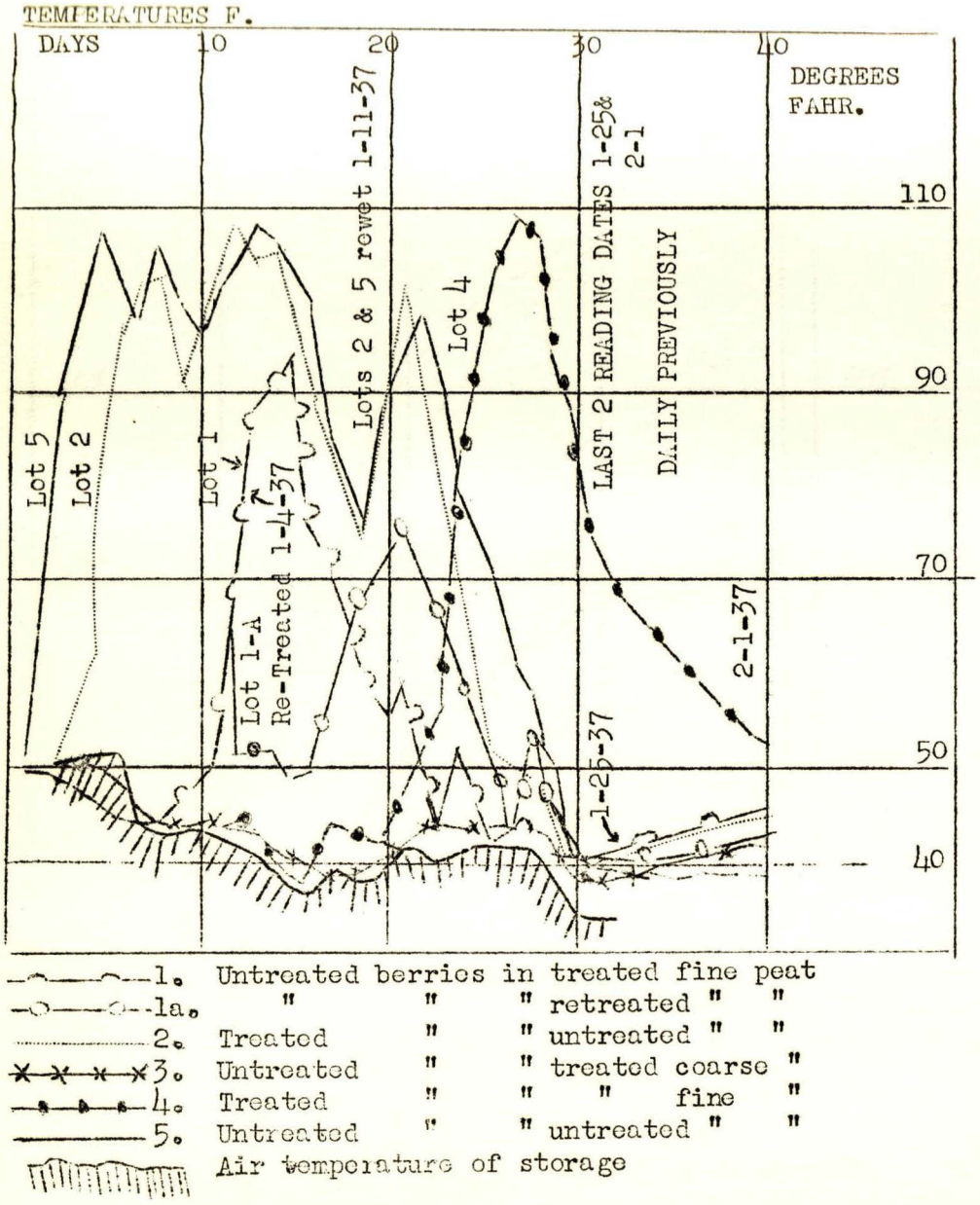


HACKBERRY (Celtis occidentalis) Ha-5
F-38-13 & F-39-17

Routine tests of stores.

DATA: All of this seed, totaling some 5800 lbs., was depulped and handled in temperature at or near freezing, so no fermentation occurred prior to or during the stratification period, starting 12/28/39-1/2/40. Temperature 34-40°F. Test sowings were made 3/1, 3/15, 3/27, 4/5, and 4/16/40.

CONCLUSION: This depulped but unfermented seed after-ripened very poorly as compared with previous years when fermentation occurred.



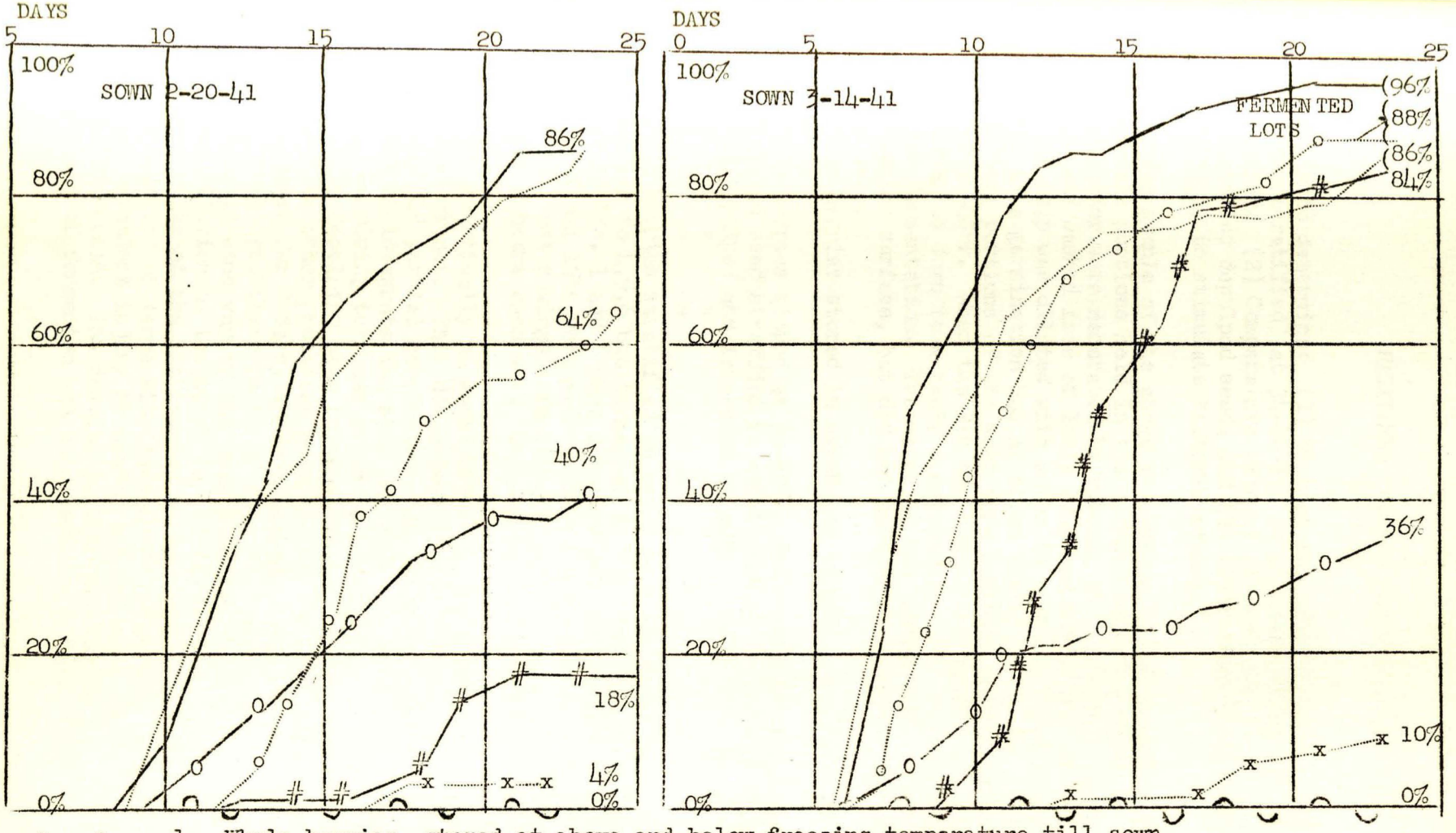
HACKBERRY (Celtis occidentalis) Ha-6
F-36-26

Effects of treating seed and/or peat with formaldehyde solution to prevent heating in stratification.

DATA: The idea of controlling excessive fermentation and heating of stratified Hackberries (and Russian Olive) was tried in the following variations. The "treated" berries were soaked 1½ hours in 1:100 solution of formaldehyde and water. Fine granulated domestic peat (Colby's) was treated by moistening with formaldehyde solution 1:100; and some coarse imported peat was treated with 1:50 solution. All lots were stratified 12/23/36. Temperatures of the air and of the interior of each of the lots were recorded daily and plotted on the accompanying chart. Sowing tests were made 4/4/37 and total germinations at the end of 4 weeks are:

1. Untreated berries in peat treated 1:100 51%
1a. Same as 1 but retreated 1/4/37 52%
2. Treated berries in untreated peat 28%
3. Untreated berries in treated coarse peat 2%
4. Treated berries in peat treated 1:100 20%
5. (Control) Untreated berries in untr. peat 16%

CONCLUSION: Highest viability occurred in the lot in which fermentation caused brief though severe heating. The lot in which the treatment eliminated fermentation germinated only 2%. While it is impossible to prove that the low viability may not be due to injury by the treatment, the result is similar to that of other tests of untreated whole berries which did not get to fermenting in untreated peat (Ha-1,2,&3). It was not determined whether the lower viability of the lots (100-110°F. for 10 days) were injured, or merely lacked time for after-ripening aft. low temp.



1. Whole berries, stored at above and below freezing temperature till sown
2. " " " " 35-40°F. till sown, no stratification
3. Depulped seed, not fermented. Stratified 12/18/40
4. " " fermented 2 days, " 12/20/40
5. " " " 4 " " 12/22/40
6. " " " 9 " " 12/27/40
7. Whole berries, stratified at 34-40°F. 12/27/40
8. Depulped seed, fermented 13 days, stratified 12/31/40

HACKBERRY (Celtis occidentalis) Ha-7
E-40-27

For description please see **next page.**

HACKBERRY (Celtis occidentalis) Ha-7
E-40-27

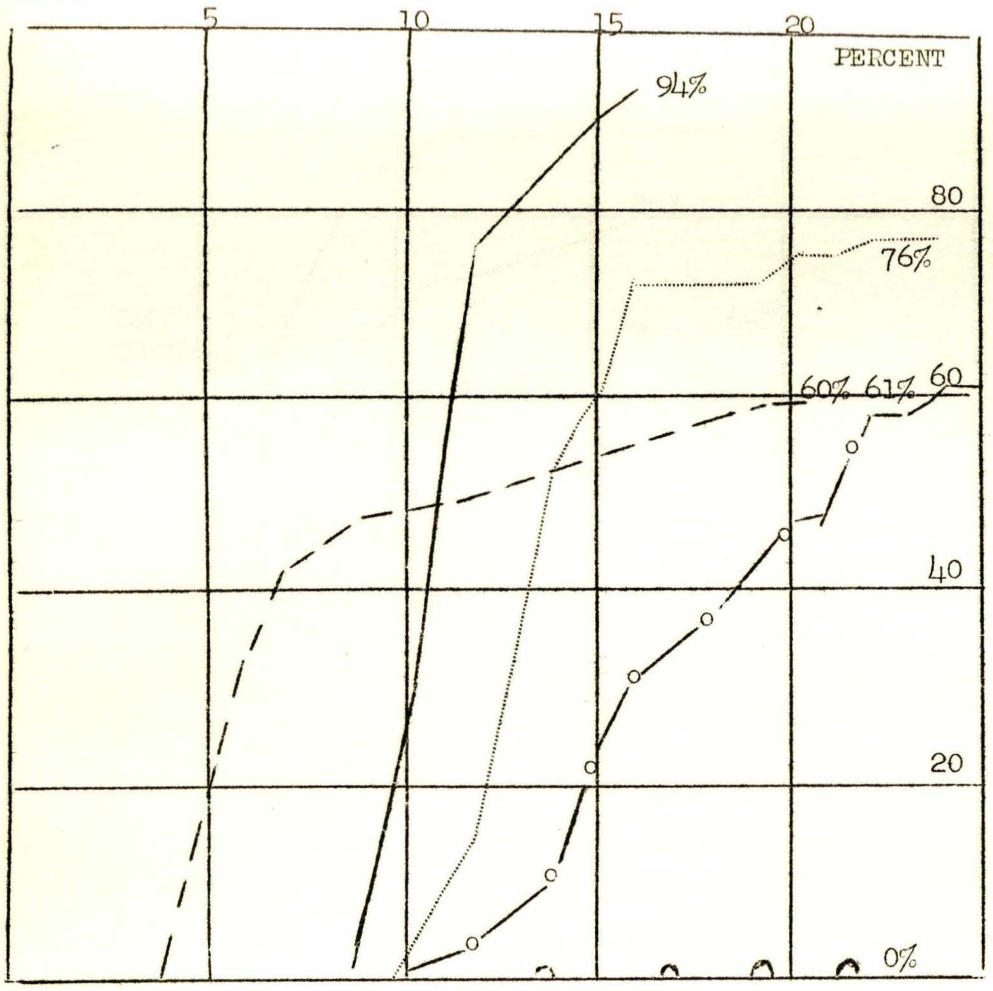
Tests to determine: (1) Whether any after-ripening occurs in whole Hackberries (not stratified) at 34-40°F., or at temperatures alternating above and below freezing. (2) Comparative rate of after-ripening of stratified whole berries and of stratified depulped seed; and (3) Effectiveness of fermentation prior to stratification, to stimulate "after-ripening."

DATA: Random sample of the above collection lot of hackberries was divided, and three small portions held in the manner indicated below as Nos. 1, 2, and 7. The remainder were macerated by rubbing on a coarse screen, and a small portion of the seed washed free of loose pulp and stratified (#3). The remainder of the seed and pulp was diluted with water to a consistency of thick gravy, and put to ferment in a germination bos at about 75-80°F. On the 2nd, 4th, and 9th days thereafter, portions of the seed were removed, washed, and stratified in moist peat at 34-40°F. When the 9th day sample was taken, the pulp had evaporated and fermented down to a pasty consistency, so it was thinned with more water to continue fermentation. The material had become very yeasty and had patches of mould on the surface, but did not develop any acetic acid odor. The lots to be tested were:

1. Whole berries stored in warehouse temperature above and below freezing till sown.
2. Whole berries stored at 34-40°F. from 12/17/40 until sown.
3. Depulped seed stratified in moist peat at 34-40°F. beginning 12/18/40.
4. Seed depulped and fermented in pulp 2 days, then stratified at 34-40°F. 12-20-40
5. " " " " " " 4 " " " " " 12-22-40
6. " " " " " " 9 " " " " " 12-27-40
7. Whole berries stratified in moist peat at 34-40°F. (12/27/40)
8. Similar to 4,5,6 but fermented in pulp re-diluted on 9th day. Strat. 12/31/40

Samples of Nos. 1 and 8 were sown without stratification 12/31/40 but none grew. Sowings of all lots were made 2/20/41 (about 2 Mos. strat.) and 3/14/41 (2 3/4 Mos.) All test sowings were carried at temperature of 80°F. for 15 hours and 70°F. for 9 hours each day. Sowings were in parallel rows in the same flat.

CONCLUSION: Practically no germination was obtained from whole berries, whether stratified or not. This disagreement with field practice in that fall-sown berries yield partial germination, may be reconciled by the fact that soil microorganisms disintegrate the skin and pulp of the berries during fall and early winter. Depulping the seed prior to stratification obtained only fair germination; while depulping plus fermentation for a few days greatly stimulated "after-ripening" or other processes essential to the germination of the seed. In the lot fermented for 9 days, which germinated more slowly and in the first test to lower percentage, there is in my opinion, indication that the results were influenced in some way by the high concentration of the fermenting pulp; and that the dilution on the ninth day relieved the condition to the extent shown in the results of the lot carried to the 13th day. This action is not paralleled in the behavior of fermenting seed where conversion of alcohol to acetic acid occurs. Permanent injury by acetic acid proceeds rapidly as the concentration of acid increases. The results of the test are in general agreement with previous tests of fermented and unfermented hackberry seed.



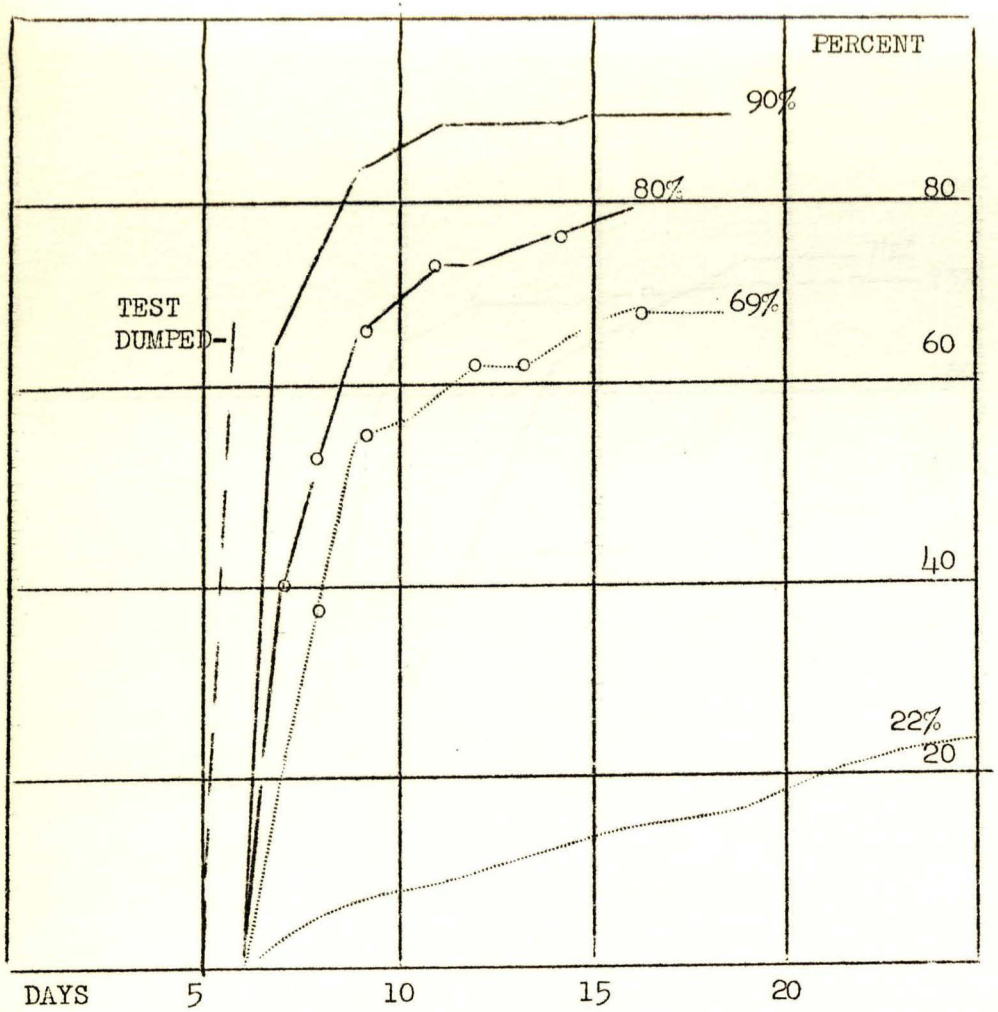
NORTHERN CATALPA (Catalpa speciosa) Cat-1
F-36-30, F-38-21, F-39-43, & F-40-23

Routine tests indicate that maturity of crop affects the keeping quality of the seed.

DATA: Collections of F-38-21 were mostly of green to very green pods. F-39-43 were all collected in March 1940 of pods hanging on trees over winter. F-40-23 was collected when most of the pods were starting to turn brown, though some were still rather green. Storage was in burlap bags at warehouse temperature. Random samples from main supplies were used for testing. Tests sown 2/14/41 were germinated at 80°F. for 15 hours a day and 70°F. 9 hours a day.

CONCLUSION: The 1939 (tree ripened) seed germinated 94% in the spring of 1940 and 76% in spring of 1941; while the 1936 seed collected green was dead by the spring of 1940. No record of the initial viability of the 1938 seed was kept, but it gave satisfactory field stands the first season. The 1940 crop collected in the ripening stage had only two-thirds the initial viability of the 1939 fully mature seed at the same relative age.

OSAGEORANGE (Toxylon pomiferum) Os-1
F-36-22

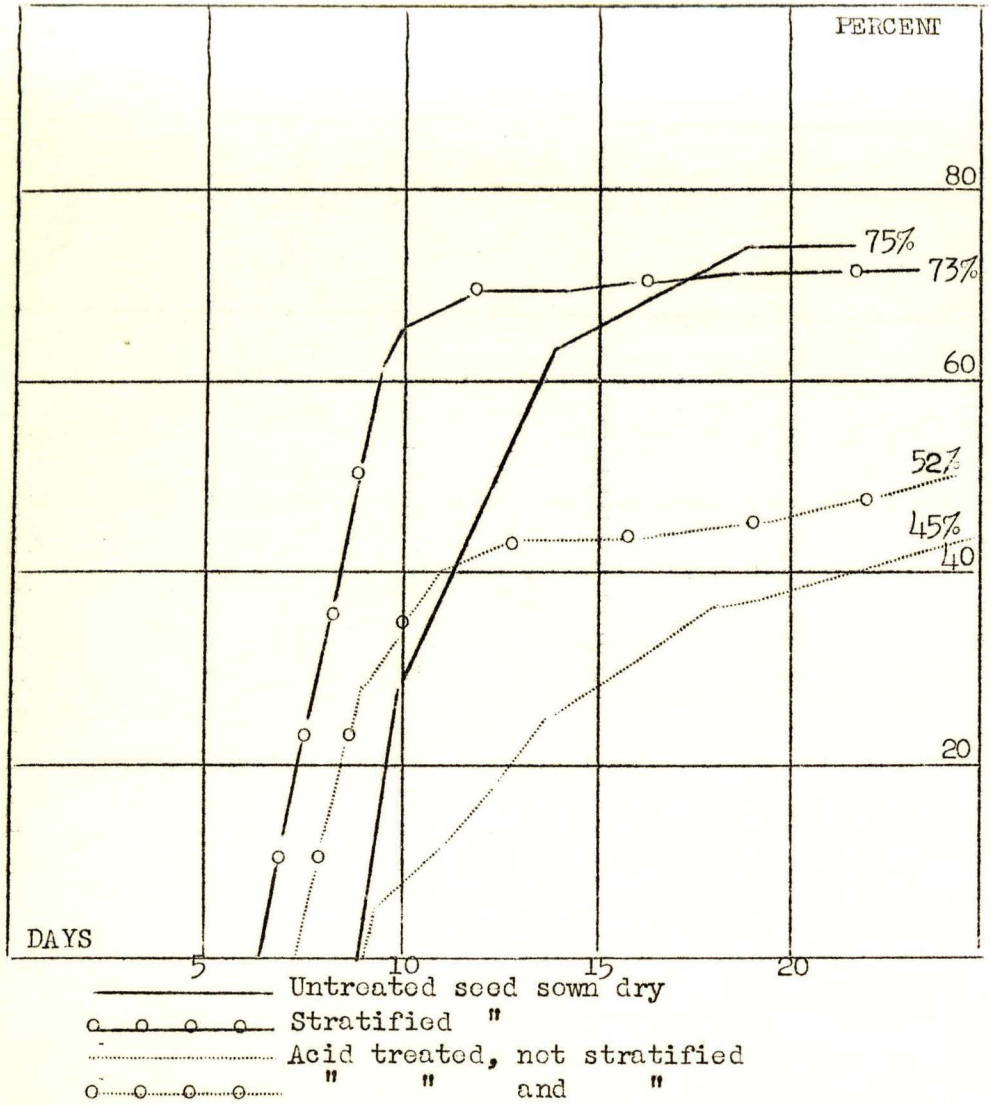


Stratified 33 days from 1/28/37
Soaked 42 " " 3/30/37
" 18 " " 1/28/37
" 10 " " 1/28/37
" 15 " " 3/30/37

Soaking or stratification as a pre-sowing treatment.

DATA: Random sample was divided for treatments and lots stratified 33 days at after-ripening temperatures, soaked 10 days and 18 days, respectively, prior to sowing 3/1/37. Another sample stratified 3/30/37 was sown 4/14/37 and 5/11/37. Water was changed daily on the soaked seed.

CONCLUSION: Stratification for a month at after-ripening temperature; or soaking for 18 days or longer, changing the water daily renders a high percentage of the seed viable.



PONDEROSA PINE (Pinus ponderosa) Po-1
E-39-26

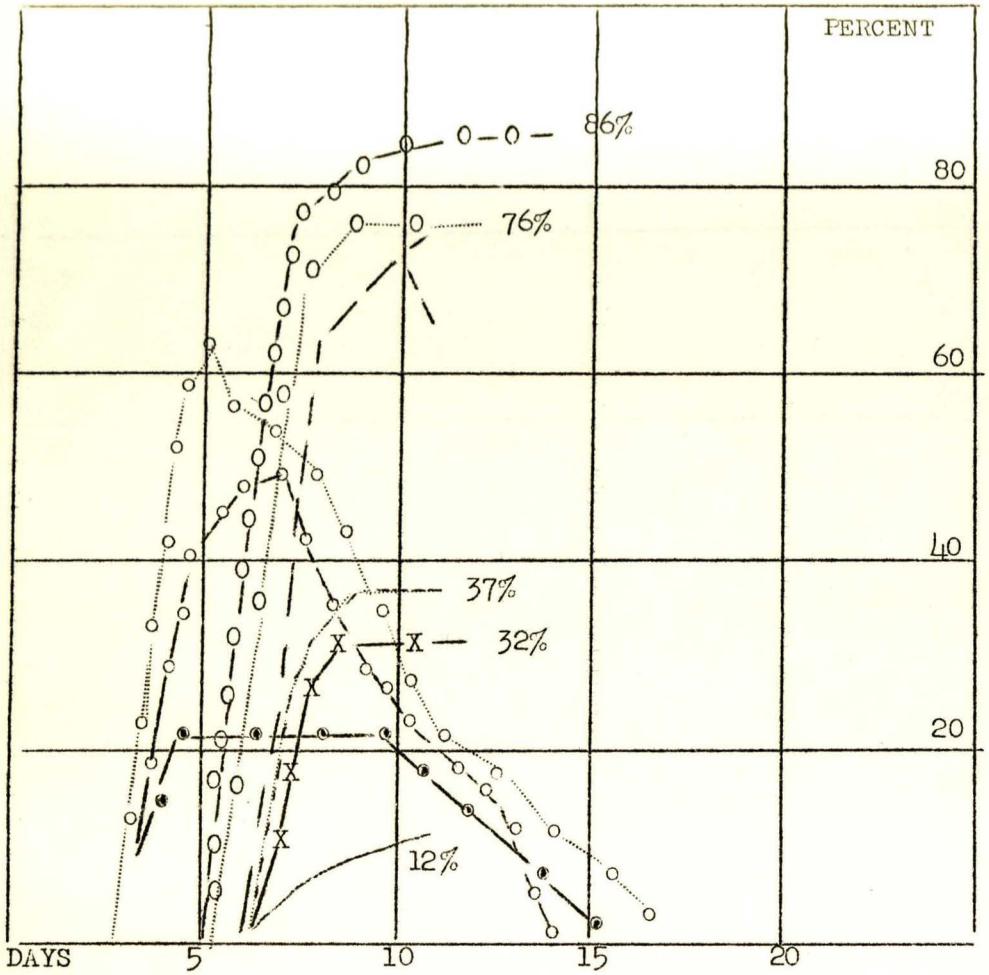
Stratification at after-ripening temperature and/or acid etching as pre-sowing treatment.

DATA: Random sample of this seed was divided into three lots and treated:

1. No acid treatment.
2. In sulphuric acid 15 minutes.
3. In sulphuric acid 40 minutes.

After thorough washing and drying, half of each of these lots were stratified in moist peat at 35-40°F. for one month; and test sowings of the six lots made 1/17/40.

CONCLUSION: Acid treatment for 15 or 40 minutes was injurious, the injury by 15 minutes treatment being about the same as for 40 minutes. Stratification at the low temperature was beneficial for securing earlier germination and total germination within a shorter period, though it did not produce higher percentage of germination than was eventually obtained from the untreated control lot. The benefits of stratification extended to the lots partially injured by the acid treatments. Possibly the benefits of stratification are more than offset by disadvantages such as poor handling of stratified seed by mechanical drill sowers, less accurate control of sowing rates, and injury to stratified seed by acid treatment of beds after sowing.



———	Untreated seed stratified	1	month	
·—·—·—	Acid trtd. ½ hr.	"	1	"
— — — —	" " 1 "	"	1	"
X—X—X—X	Untreated seed	"	2	"
·····0·····0	Acid trtd. ½ hr.	"	2	"
—0—0—0—0—	" " 1 "	"	2	"
·—·—·—·—	Untreated seed	"	3	"
·····0·····0	Acid trtd. ½ hr.	"	3	"
o—o—o—o—o	" " 1 "	"	3	"

QUAILBUSH (Rhus trilobata) Q-1
F-39-30

Acceleration of after-ripening by acid treating prior to stratification at low temperature.

DATA: Reports from the field indicated that poor germination of this species was obtained, even following long periods of stratification. Random sample of this lot was divided and part treated with H_2SO_4 (undiluted) for 30 minutes and 1 hour, respectively. To determine that the dormancy of the seed is not solely of the impermeable seed coat type, samples of acid treated and untreated seed were sown 12/17/39 but none grew. The untreated and each of the treated lots were then stratified in moist peat at 34-40°F. until sowing tests at the end of 1, 2, and 3 months. Sowings were in non-sterile material and closely confined in the germination box; so heavy losses occurred from mould and damping off, especially in the last test. The accompanying graph is on the basis of surviving stands, the crest of which approximates total emergence.

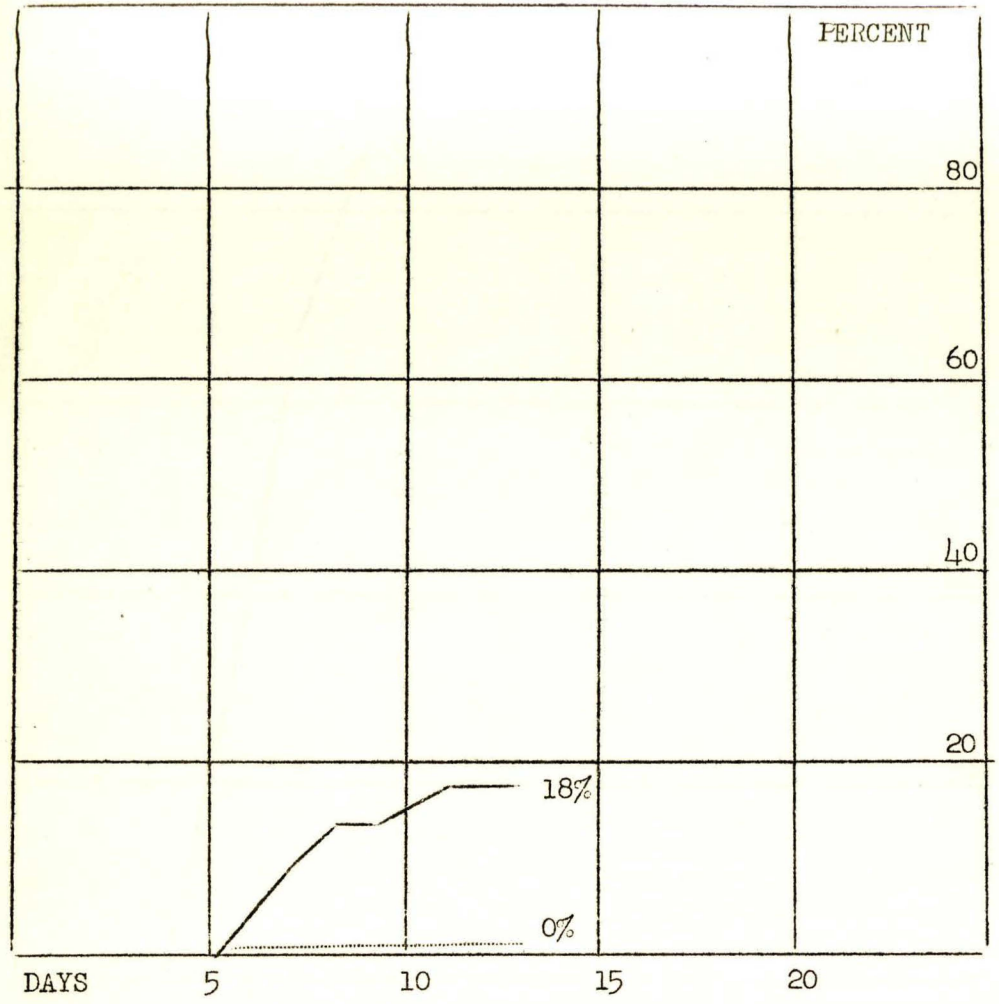
CONCLUSION: This seed has both impermeable seed coat and germ dormancy. When the seed coat is rendered permeable, by 1 hour submersion in H_2SO_4, after-ripening of the germ is accomplished by stratification for 2 months at 34-40°F. The seedlings are susceptible to damping off.

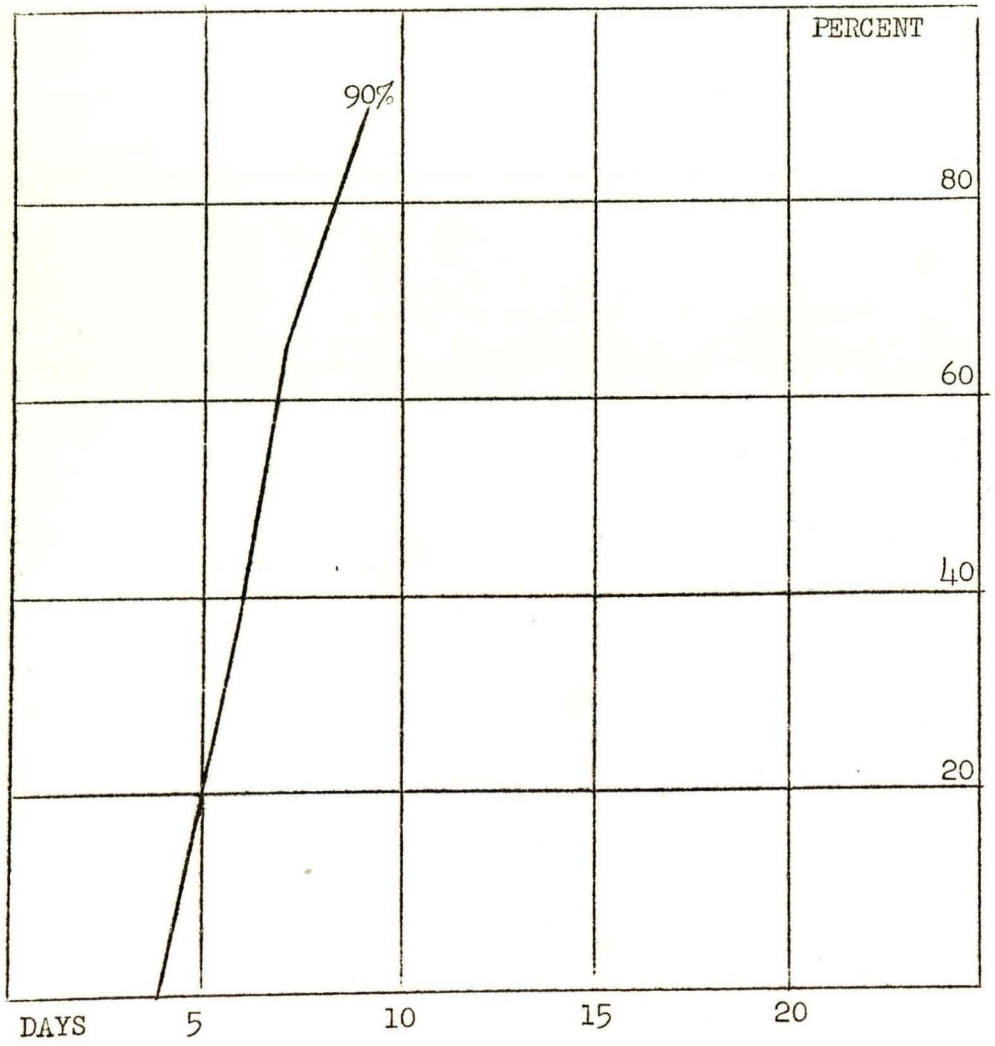
ROCKY MOUNTAIN JUNIPER (Juniperus scopulorum) Co-3
E-38-43

Acid etching to render seed-coat permeable and facilitate after-ripening.

DATA: Our supply of Juniperus scopulorum seed was divided and half of it treated with H_2SO_4 (undiluted) for 30 minutes, washed thoroughly and then stratified. The remainder was not treated, but all had been soaked in lye water during extraction and was relatively free of resin. Random samples from each lot were sown 3/15/40. (Stratification date was 12/21/39.) Field sowings at Fremont, Nebraska, of the two lots, yielded results agreeing with the germination test shown.

CONCLUSION: Acid etching of the seed was at least partially effective for breaking down the impermeable seed-coat dormancy to permit after-ripening of the germ the first winter and germination the first spring after collection. The rather low percentage of germination of the acid treated seed may be due to inadequate period of after-ripening. The percentage of germination is as high as commonly obtained from Juniperus virginiana stratified for the same period (2 3/4 Mos.) More complete testing is now under way, including stratification at warm temperatures for various periods, preceding the stratification at 35-40°F; and for scarified as well as acid etched seed.





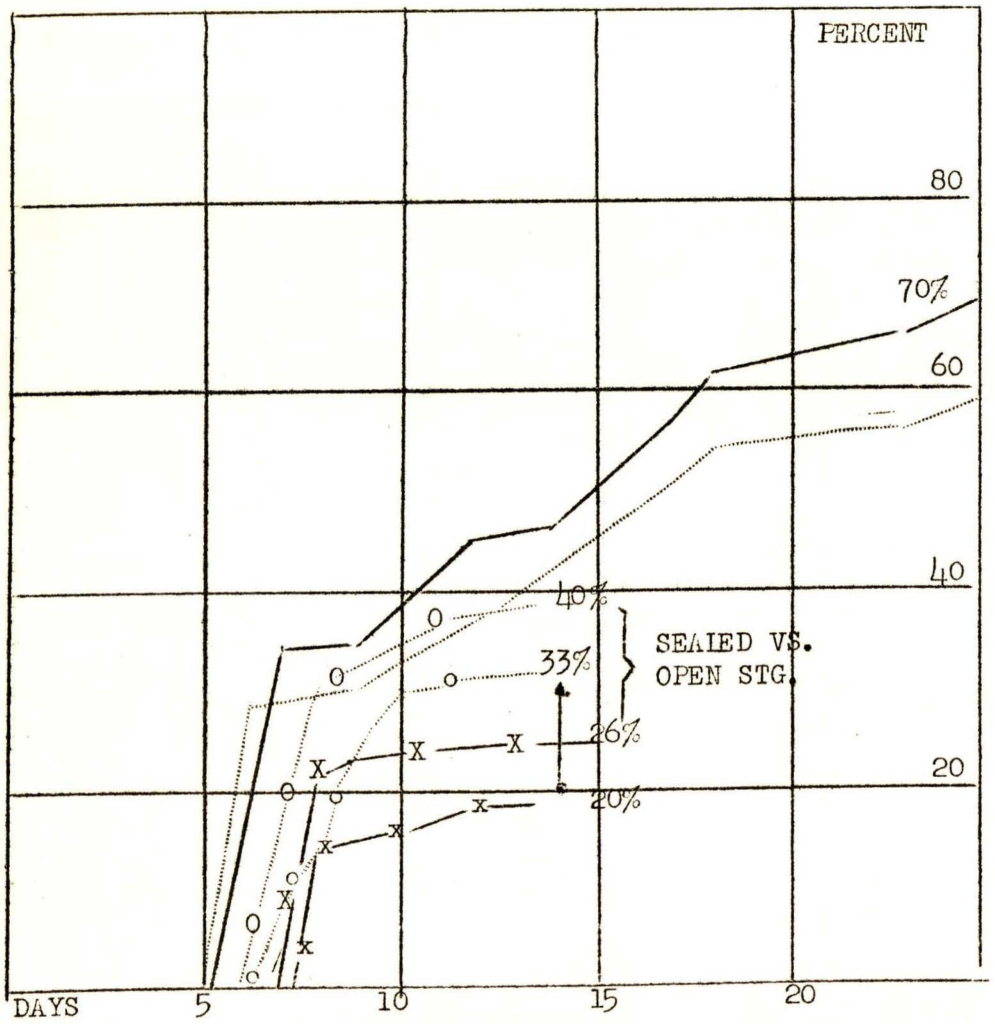
Stratified 7/17/40, Sown 10/12/41

RUSSIAN APRICOT (Prunus armeniaca) Apr-1
W-37-P29

Routine test of purchased seed.

DATA: Sample stratified at 35-40°F. 7/17/40. Sown 10/12/40.

CONCLUSION: This three-year old seed is still in good condition. Three months' stratification is ample.



Original viability, open whse. stg. seed
" " sealed " " "
10 Mos. open stg. at whse. temp.
10 " sealed " " " "
10 " open stg. at 34-40°F.
10 " sealed " " 34-40°F.

RUSSIAN MULBERRY (Morus alba tatarica) M-1
F-39-5 (Longevity test lot)

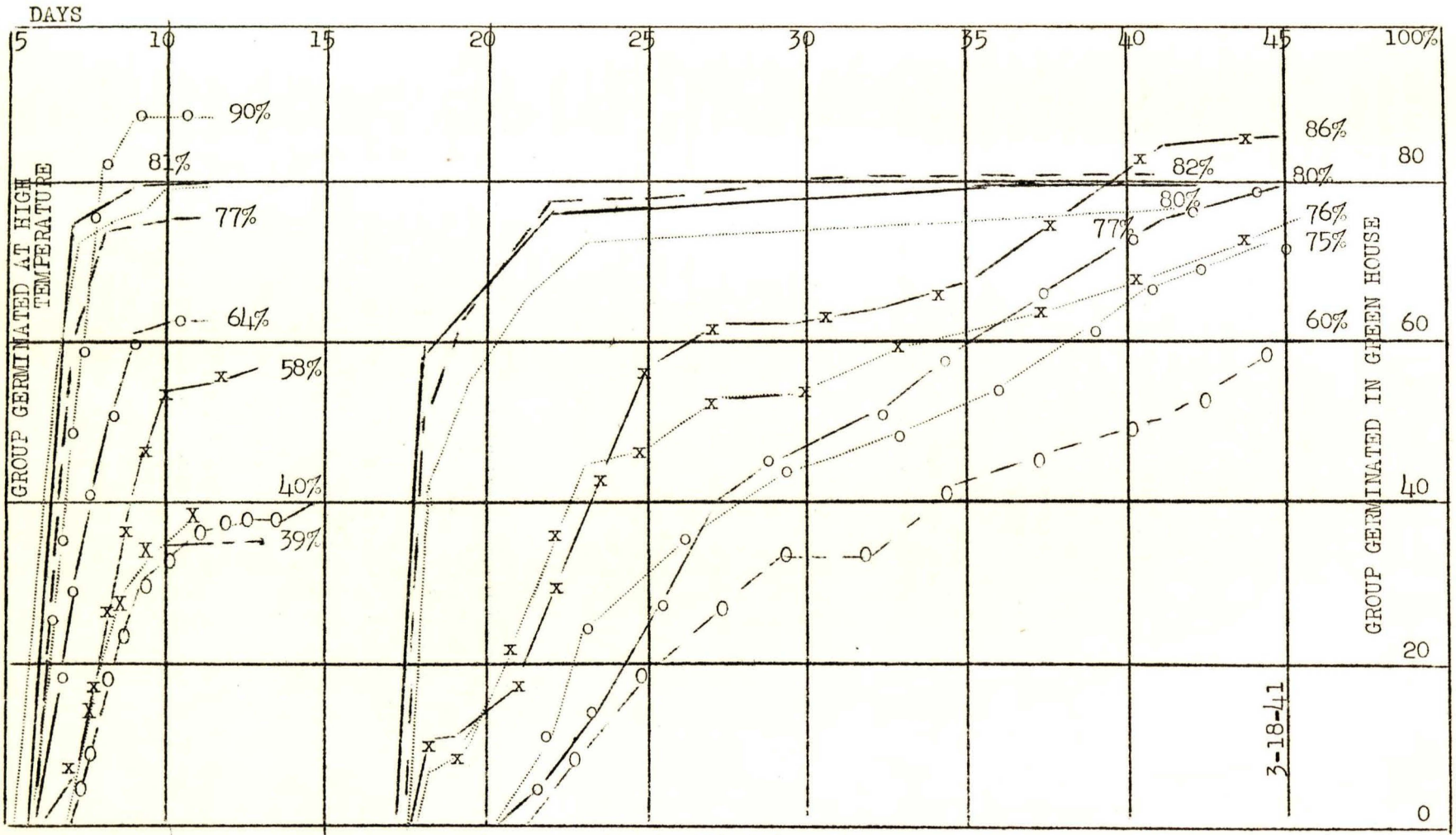
Influence of temperature and/or sealed storage upon retention of viability. Also deterioration of Mulberry seed upon removal from cold storage.

DATA: A sample of 1939 collection was divided into four lots and held in sealed and unsealed containers, at warehouse and 34-40°F. temperatures. Test sowings were made 7/18/39 and again 5/7/40 by sowing the dry seed in flats of sand-peat mixture. As demonstrated in the series of tests M-2, this seed acquires mild dormancy in storage; and dry sowings, particularly at temperatures lower than 90°F., do not reveal the full viability of the seed. However, it is believed that this test indicates fairly well the influences of sealed storage and temperature of storage. On 8/9/40 samples of the above lots were removed from storage and dry sowings made 8/9, 8/20, and 10/3/40, to investigate a report that Mulberry seed carried over in cold storage moulds and deteriorates very rapidly upon removal to warm temperature. The total germinations from these sowings were as follows:

Storage lot	Sown 8/9/40	8/20/40	10/3/40
1. Unsealed, Whse. Temp.	51%	47%	47%
2. Sealed, " "	53	53	48
3. Unsealed, Cold Stg.	51	29	7
4. Sealed, " "	67	60	47
5. F-39-5 (Main supply)	70	--	44

No. 5 was random sample from lot stored in full 55-gal. drum with tight-fitting but not sealed lid, held in 34-40°F. storage.

CONCLUSION: Cold storage is best only if in sealed or tightly closed full containers; otherwise whse. storage in sealed or tight containers is indicated. Rapid deterioration occurs to seed removed from cold stored sacks or open containers.



Large seed, stratified 1 month
Medium " , " 1 "
Small " , " 1 "
Large " , soaked 1 week
Medium " , " 1 "
Large " , sown dry
Medium " " "
Small " " "

RUSSIAN MULBERRY (Morus alba tatarica)
F-40-4 M-2

For description please see next page.

RUSSIAN MULBERRY (Morus alba tatarica) M-2
F-40-4

Tests to determine the extent to which germination percentage and rate is influenced by: (1) size of seed, (2) stratification, soaking or dry sowing, and (3) temperature of germination.

DATA: Seed used was a random sample from main stores which had been stored at 35-40°F. in tight metal container from June to November 28, thence in warehouse at below 40°F. The seed was separated by screening into large, medium, and small sized seed--the large comprising 28%, the medium 48%, and the small seed 24% of the total by weight. Portions of each lot were stratified in clean moist sand on 12/30/40 and other portions put to soak 1/23/41, changing the water daily; the remainder held dry. 100 seeds of each size stratified, soaked, and dry seed were sown 1/30/41 in each of two flats containing mixture of sand and fine pulverized peat. One of the flats was carried at 90-95°F. for 14 hours a day, and 65-70°F. the remaining 10 hours each day. Heat and light was furnished by two 150W light bulbs mounted above the flat in a partially closed box. The other flat was kept in a greenhouse where the minimum night temperature was 50°F., and range of daytime temperatures 60-78°F. according to the weather. A third flat not recorded in the accompanying chart was carried at 60-70°F. for 10 hours a day and 50°F. for 14 hours a day during the first two weeks. It was then transferred to 70-80°F. range to see the acceleration of germination by the temperature increase.

CONCLUSION:

1. Size of seed did not greatly affect the precentage of germinations. Each size gave best germination in one or more groups and poorer in others. The larger seed showed only moderately more vigorous germination and growth the first week; but later growth showed much greater difference. This was especially noticeable in the stratified seed lots which emerged within a five-day period and produced even-aged stands. At the end of three weeks' growth in the greenhouse, the seedlings from the largest seed were 1½" tall, while those from the smallest seed were 3/4" tall. The difference in root growth was even more striking. Those from the large seed had bushy roots at least three times as extensive as those from the smallest seed. Those from medium sized seed were intermediate in size.

2. Stratification was optimum pre-sowing treatment. The superiority of stratified seed becomes much greater at lower than optimum temperatures. Soaking the seed a week gave nearly as good results when germinated at high temperatures, and may be a useful expedient for quickly preparing "carried-over" seed for late spring re-sowings of failed stands. The mild dormancy and its relief by stratification or soaking, as shown in this test and others of seed F-39-5 and H-36-40 was missing from F-36-4. That seed, held at ordinary warehouse storage from July 1936 until April 1937 germinated 92% during the 4th to 8th days after sowing dry seed. It is not know whether it was an inherent difference in the crop, or in some factor concerned with extraction.

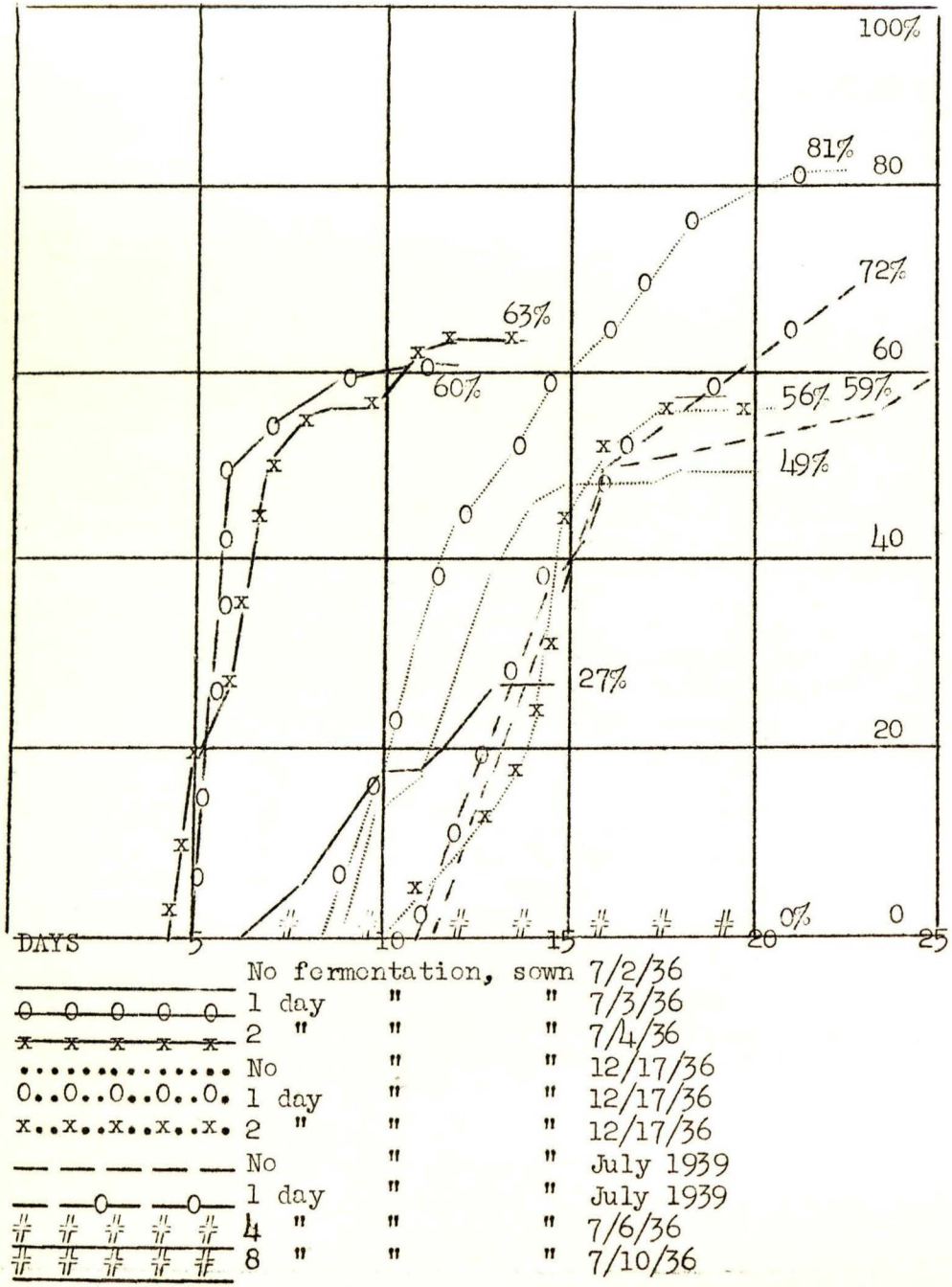
3. Temperature of 90-95°F. most of the day and 70°F. the remainder, gave outstandingly better germination. Lower temperatures induced a rest period of two to three weeks after which only the stratified seed responded with rapid, high percentage germination. In another test not recorded here, but run at 80°F. for 15 hours a day and 70°F. the balance, the rest period was 9 days, after which soaked seed germinated rather fast, but the dry seed germinated only 6%.

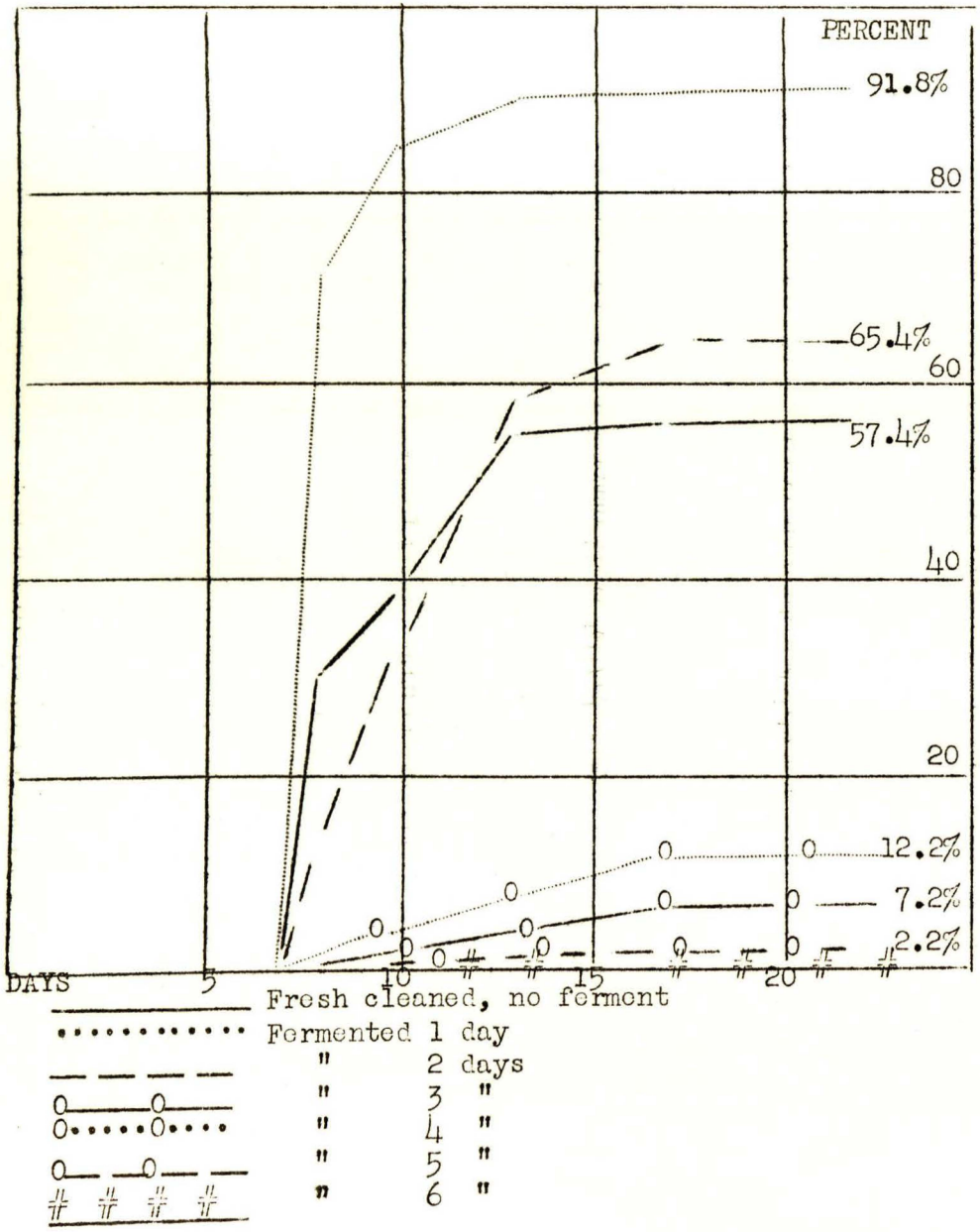
RUSSIAN MULBERRY (Morus alba tatarica) M-3
F-36-4 (Special lot)

Effects of fermentation, upon viability and keeping qualities of the seed.

DATA: A quantity of fresh mulberries were divided into lots, one of which was macerated and the seed extracted at once; others were fermented in enough water to cover the berries well, for periods of 1, 2, 4, and 8 days, before extraction. The period of the treatment 7/2-10/36 was an unusually hot spell when day time temperatures of 96-110°F. prevailed and nights were hot. Consequently fermentation and conversion of alcohol to acetic acid was much more rapid than would occur at lower temperature. Sowing tests were made of each lot at the time of extraction and again 12/17/36. Lots having no fermentation and 1 day fermentation were re-tested in July 1939, (after 3 years' storage unsealed, at warehouse temperature).

CONCLUSION: Fermentation of mulberries for one day increases the viability of the seed, as well as facilitating extraction. The seed from berries so fermented still showed higher viability than fresh cleaned seed, at the end of 3 years' storage at room temperature. Mulberry seed is sensitive to injury by acetic acid and fermentation longer than 48 hours in warm weather is apt to kill the seed.



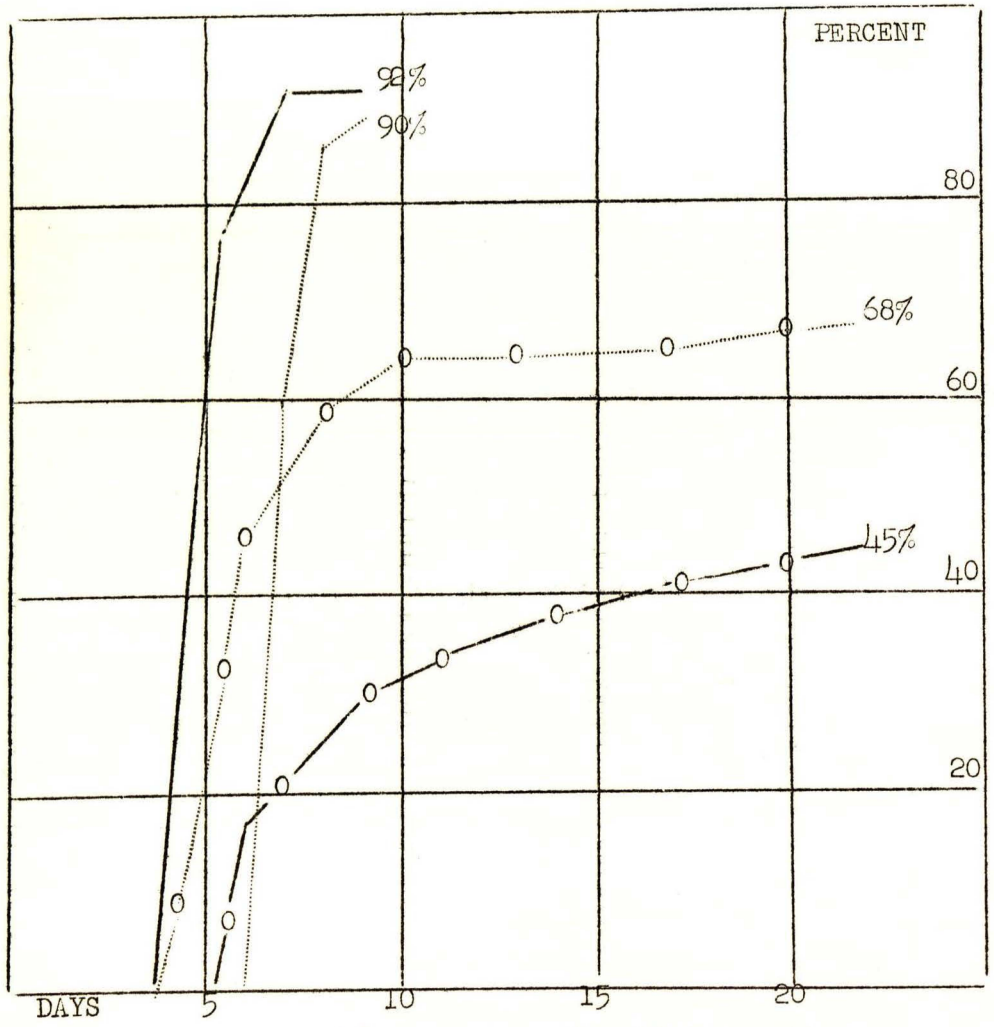


RUSSIAN MULBERRY (Morus alba tatarica) M-4
F-37-4 (Special lot)

Effects of fermentation, upon viability of seed. Repetition by Alba H. Briggs in 1937, of experiment by Carl A. Taylor in 1936.

DATA: A quantity of fresh mulberries were divided into lots, one of which was macerated and the seed extracted at once; others were fermented in enough water to cover the berries well for periods of 1, 2, 4, 5, and 6 days. Fermentation was in room where temperatures of 65-80°F. prevailed most of the time. Test was by field sowing 7/13/37.

CONCLUSION: Fermentation for one day increased the viability of the seed about 50%. Seed fermented 2 days germinated to slightly higher percentage than fresh cleaned seed. Fermentation longer than 2 days produced severe injury to the seed. Mulberry seed is much more sensitive to acetic acid injury than is Chokecherry, Russian olive, and others having a heavy seed coat.



F-36-4 Sown dry after 10 Mos. storage
F-36-4 Soaked 8 days, 10 " "

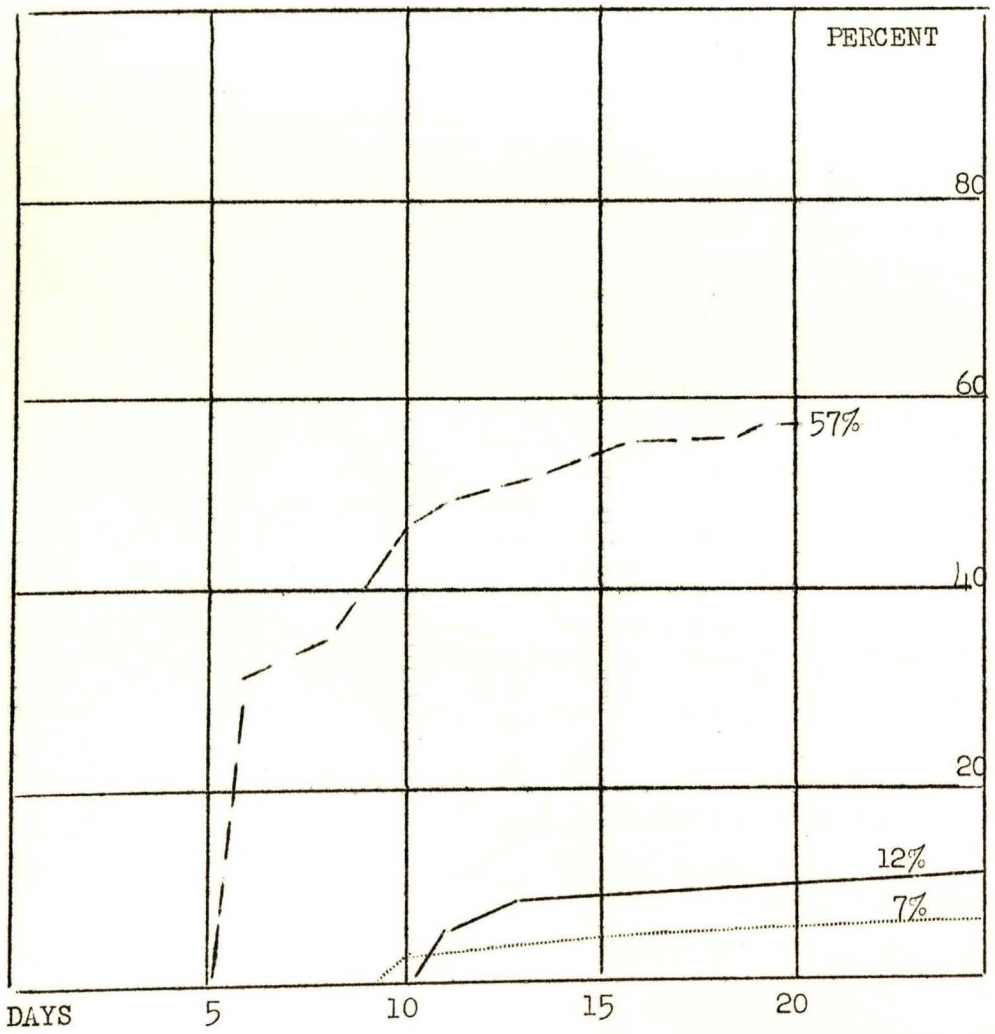
H-36-40 Sown dry after 10 Mos. storage
H-36-40 Soaked 8 days, 10 " "

RUSSIAN MULBERRY (Morus alba tatarica) M-5
F-36-4 and H-36-40

Routine tests show wide difference in behavior of several lots from same year's crop.

DATA: Both samples of 1936 seed, stored until 4/24/37 were tested by sowing dry seed soaked 8 days, changing the water daily. Tests ran concurrently in the same germination chamber. Germination temperature was not recorded.

CONCLUSION: Lack of data concerning the details of handling in extraction and storage prevent fixing responsibility for the different germination behavior of the two lots. The sluggish germination of H-36-40 dry sown, is rather typical of F-39-5 and F-40-4. (See M-1 and M-2 graphs). Indicates necessity of testing before drill-sowing of dry carry-over seed.



Seed soaked 19 days
" stratified 4 months
" cut to expose embryos

RUSSIAN OLIVE (Elaeagnus angustifolia) R-1
E-35-8 and E-36-15

Test to determine whether species has true germ dormancy or impermeable seed coat.

DATA: A small sample of berries (E-35-8) was divided for the following treatments:

1. Berries soaked 2 days then depulped and the seed soaked another 17 days, changing the water daily until sown, 9/14/36.
2. Berries soaked a few days, depulped, and the seed stratified in sand at after-ripening temperature 8/15-12/21/36. Sown 12/21/36.
3. Clean seed E-36-15 was prepared by carefully slicing away one side of the seed coat until the chamber containing the embryo was entered. This seed was sown without any stratification 12/18/36.

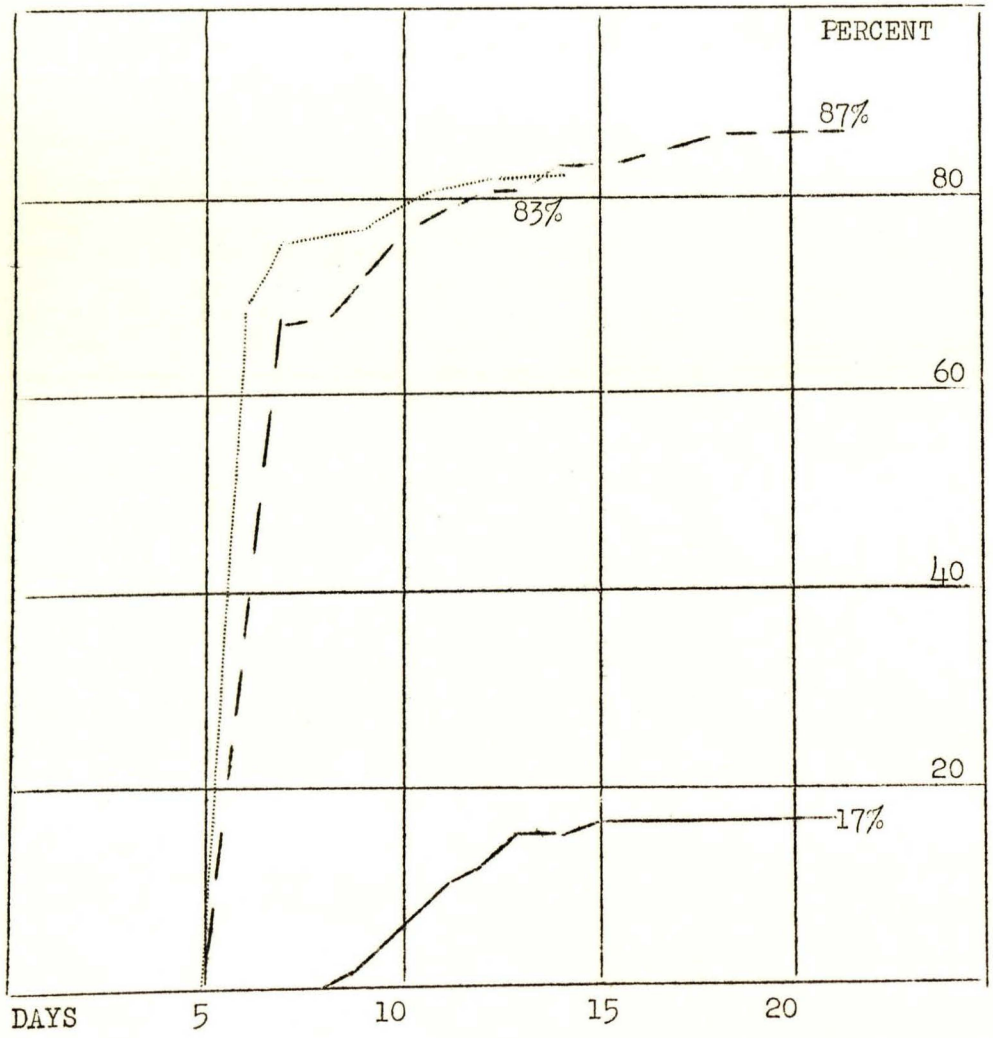
CONCLUSION: This seed has germ dormancy requiring after-ripening at low temperature. The period used was considerably longer than the normal requirement of the species, and the seed may have passed the culmination of via bility at time of sowing. (See R-2). Prolonged soaking is not a satisfactory substitute for stratification for the usual period at low temperature. Only 7% of the dormant embryos grew, upon exposure to moisture and favorable temperature.

RUSSIAN OLIVE (Elaeagnus angustifolia) R-2
E-35-8

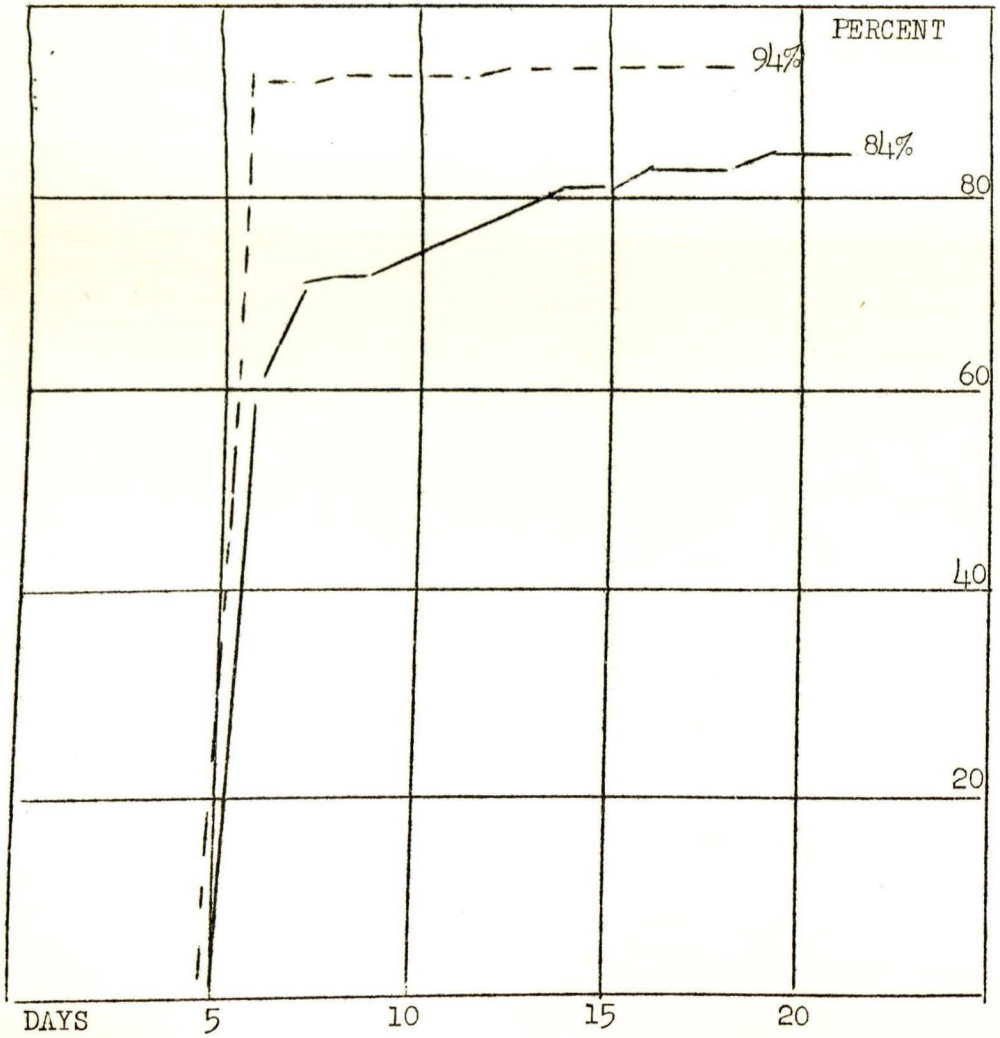
Routine test of stores indicates that most of the seed was viable at the end of 3 months' stratification, though few were viable at the end of 2 months.

DATA: Composite random samples of our regular supply of stratified seed were taken at the end of 2, 3, and 3 1/3 months; and germinated by sowing in flat of sand and peat mixture.

CONCLUSION: Culmination of viability for this lot occurred toward the end of 3 months' stratification at after-ripening temperatures of 34-40°F.



Stratified 2 months
" 3 "
" 3 1/3 "



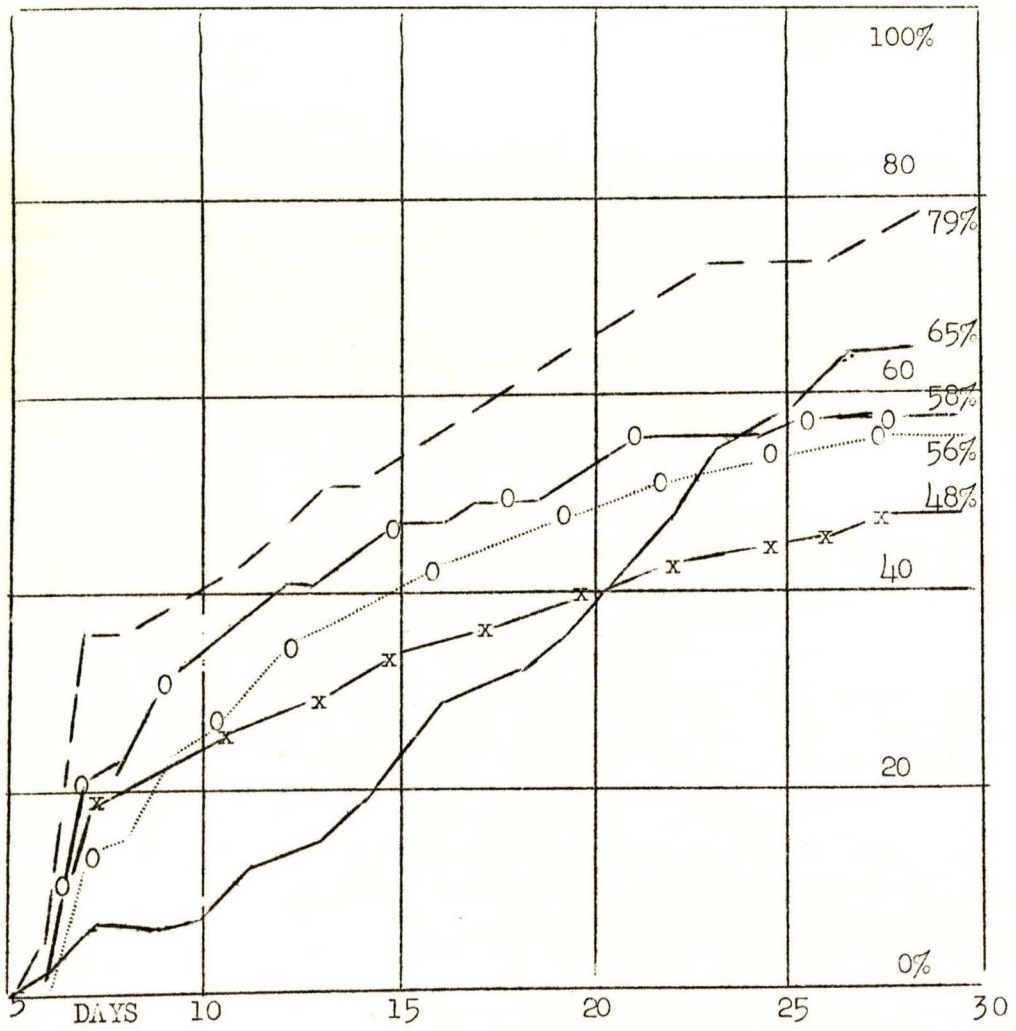
Seed stratified 3 months
" " 3 1/3 "

RUSSIAN OLIVE (Elaeagnus angustifolia) R-3
E-36-15

Routine test of stratified stores confirm rapid culmination of viability at end of third month of after-ripening temperature.

DATA: Composite random samples were taken from stratified seed held in ice cans about 42" tall. Samples from tops of cans were sown 3 months after stratification; and from bottoms of cans 3 1/3 months after stratification. This seed was in moist sand. Temperature at time of stratification was 50°F. and was not lowered to the 34-40°F. range for about 10 days (See R-5); so the after-ripening period was about 10 days less than the stratification period.

CONCLUSION: This test in conjunction with R-1 indicates rapid culmination of viability of this species toward the end of 3 months' stratification at 34-40°F. The more limited aeration of seed stored at the bottom of deep containers did not seem to be detrimental.



Heating checked 2nd day
" " 6th "
" " 12th "
" " 18th "
" not checked

RUSSIAN OLIVE (Elaeagnus angustifolia) R-4
E-36-15

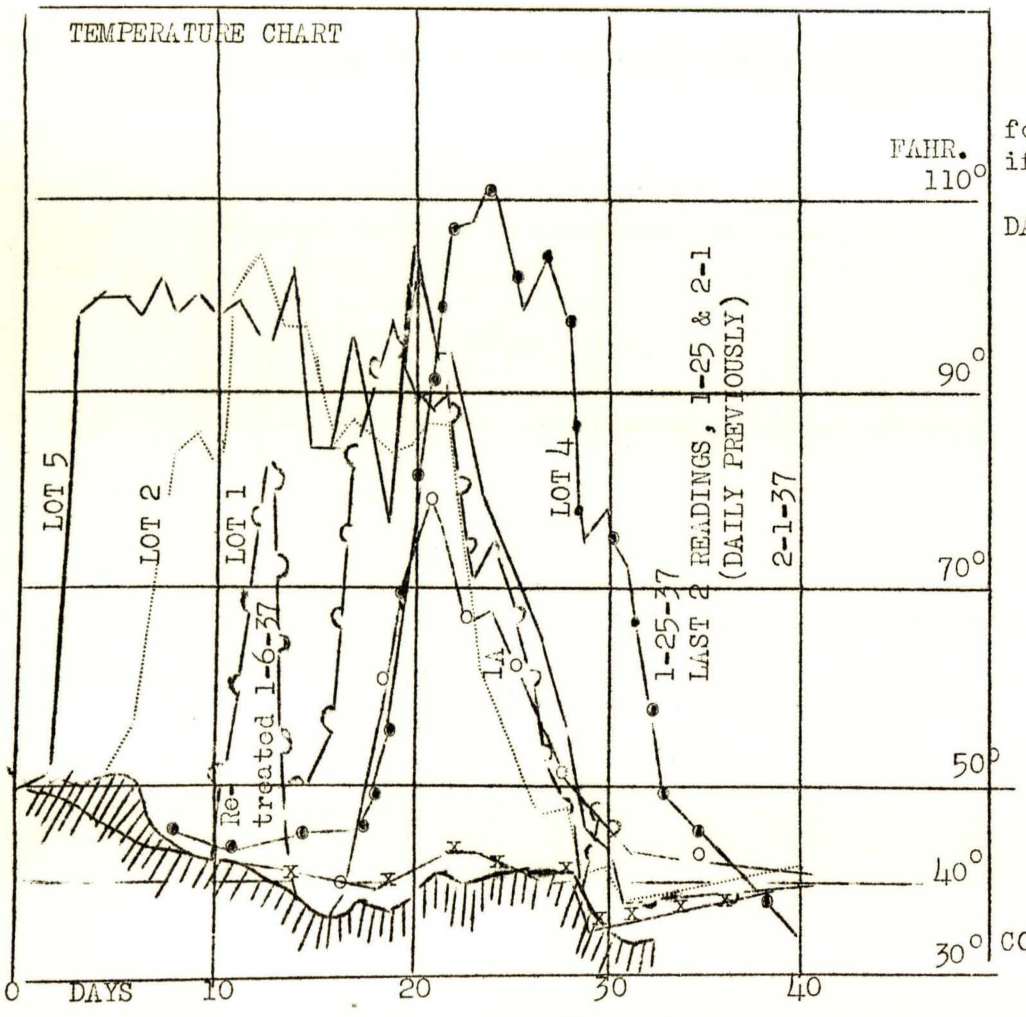
Fermentation at beginning of stratification period accelerates after-ripening.

DATA: Whole berries were mixed with sand 1:2 ratio on 12/1/36 and stored in basement which was then 45-50°F. They started heating by fermentation on 12/18/36 and samples were removed at various intervals and checked by depulping and restratifying in clean peat. Temperature of the lot rose to about 92°F. on 12/20, when the first sample was removed, and was back to normal by 12/26. Other removals were 12/24-30 and 1/5/37, the remainder of the lot being left as stratified berries. Some delay in getting the storage cellar temperature down to 40°F. as well as the time during which the berries were warm from fermentation, reduced the effective after-ripening period to about 2 to 2½ months. As no sample was obtained before any heating occurred, the test can only indicate the severe heating this seed will stand without injury; and the fact that the lot having least heating showed most sluggish germination--a characteristic of incomplete after-ripening.

CONCLUSION: The lot receiving 6 days' fermentation to the point of severe heating, germinated most rapidly and to highest percentage of any of the lots. The lot which had fermentation, checked 2 days after heating began, showed slowest rate of germination, though ultimately a higher percent of germination than some of the lots fermented for longer periods.

RUSSIAN OLIVE (Elaeagnus angustifolia) R-5
E-35-8

Effects of treating seed and/or peat with formaldehyde solution to prevent heating in stratification.

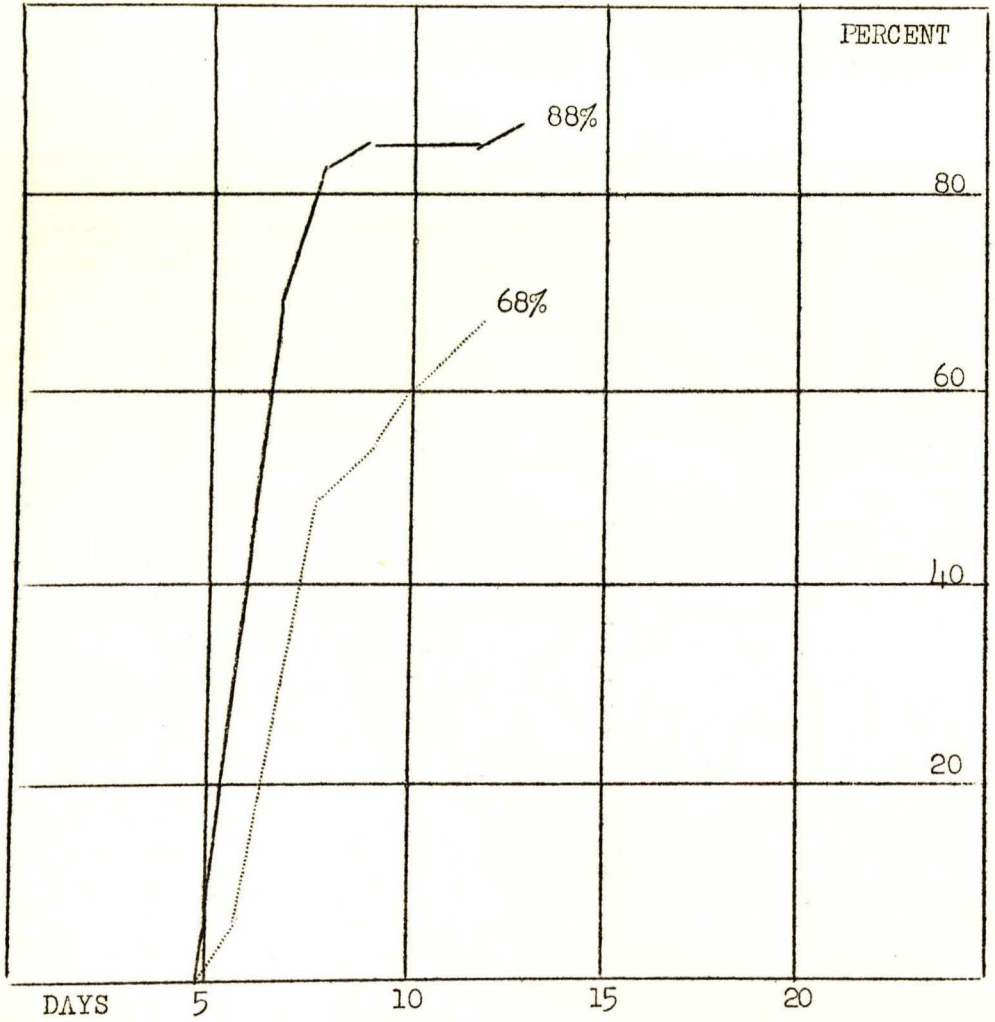


1. Untreated berries in treated fine peat
1a. Same as 1 but retreated 1/4/37
2. Treated berries in untreated peat
3. Untreated berries in treated coarse peat
4. Treated berries in treated fine peat
5. Untreated berries in untreated peat
Air temperature of storage

DATA: The idea of controlling excessive fermentation and heating of stratified Russian olive berries (and Hackberry) was tried in the following variations, by Messrs. Wright and Taylor. The "treated" berries were soaked 1½ hrs. in 1:100 solution of formaldehyde and water. Fine granulated domestic peat (Colby's) was treated by moistening with formaldehyde solution 1:100; and some coarse imported peat was treated with 1:50 solution. All lots were stratified 12/23/36. Temperatures of the air and of the interior of each of the lots were recorded daily to 1/25/37 and again on 2/1/37, as shown on the accompanying chart. Sowing tests 4/4/37 gave the following germinations by the end of four weeks:

1.	Untreated berries in peat treated 1:100	39%
1a.	Same as 1 but retreated 1/4/37	68%
2.	Treated berries in untreated peat	11%
3.	Untreated berries in treated coarse peat	4%
4.	Treated berries in peat treated 1:100	15%
5.	(Control) Untreated berries, untr. peat	3%

CONCLUSION: Highest viability occurred in the lot in which fermentation caused brief though severe heating. Lot 3, in which treatment eliminated fermentation, germinated only 4%, though this may be due to injury by the higher concentration of formaldehyde. The lower viability of lots which heated to 100-110°F. for 10 days might be due to either injury or lack of time for complete after-ripening after the low temperature was resumed. More satisfactory solution of the problem is to depulp the seed before stratifying, thus limiting fermentation to pulp residue clinging-seed.



Control, stratified 3 months

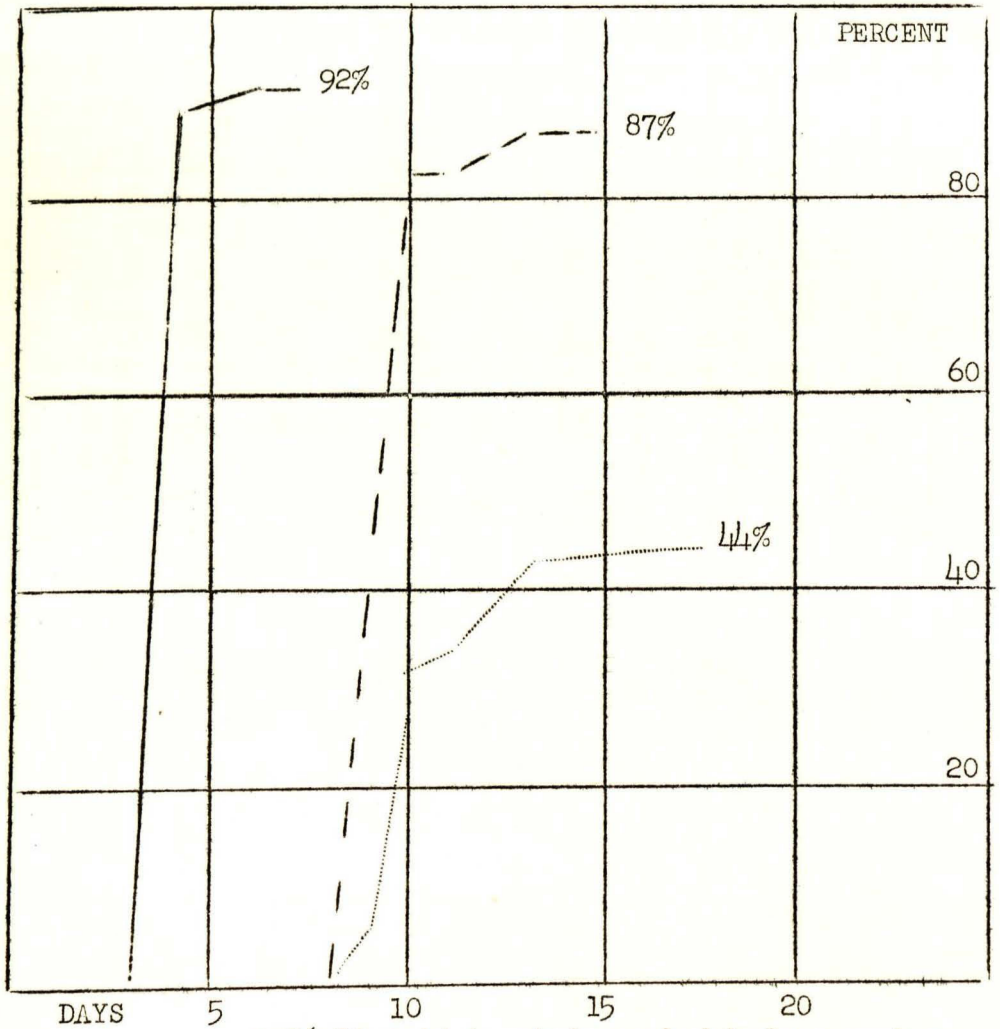
..... Vitamin B_1 treated and stratified 3 months

RUSSIAN OLIVE (Elaeagnus angustifolia) R-6
E-38-16

Vitamin B_1 treatment prior to stratification.

DATA: Treatment consisted of soaking the depulped seed for 1 day in Vitamin B_1 solution made by 5 drops of stock solution to 1 quart of water, then stratifying in peat moistened with 2 drops of stock solution to 1 gallon of water. Control lot was soaked the same period in water and stratified in moist peat 12/19/39 at 34-40°F. Sowing test was 3/15/40.

CONCLUSION: Since the treated lot germinated somewhat slower and to lower total percentage; the treatment did not appear to be of any benefit.



F-36-31 Acid treated, soaked before sowing
F-38-17 " " 1 3/4 hrs.
F-38-17 " " (poorly) 21 Mos. prior to sowing

THORNLESS HONEYLOCUST (Gleditsia triacanthos inermis) HL-1
F-36-31 & F-38-17

Routine tests, including seed acid etched 21 months prior to testing.

DATA: F-36-31 was etched in H_2SO_4 for 1½ hrs., washed thoroughly, soaked 2 days in water, and then sown 3/14/37. One sample of F-38-17 was etched in H_2SO_4 1 hr., 45 min., washed thoroughly, dried 1 day, and sown 2/13/41. The other sample of F-38-17 was from a lot which another nurseryman had acid etched in May 1939. Length of treatment was not recorded, nor test of original viability; but results from spring sowing that year indicate that treatment was inadequate, probably 50% promptly viable. Storage until February 1941 was at warehouse temperatures in burlap bags. No further treatment was given at time of testing.

CONCLUSION: 1½ to 1 3/4 hrs. is a favorable period for etching this seed in (undiluted) H_2SO_4. Acid treated seed stored for 21 months at warehouse temperatures, in burlap bags, still retained most of its initial viability.

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) Cho-1
F-39-9, Longevity test lot No graph

Purpose of test: 1. Effect of storage temperature and sealing upon the life-span of the seed. 2. Effects of fermentation or rotting of the fruits upon initial viability and retention of viability for a year or longer. 3. Feasibility of keeping seed moist from time of extraction to prevent accumulation of germ dormancy.

DATA: A batch of chokecherries from current collections in July 1939 were fresh cleaned, fermented or rotted as indicated in the tabulation below, and dried superficially indoors, after which they were placed in sealed and open storage at warehouse temperature, 34-40°F. and a few of the lots at sub-freezing (about 26°F.)

A. Fresh Berries
(1) Seed kept moist from time of extraction.
(2) Seed dried indoors.

B. Berries Fermented
(1) Fermented 2 days in water at room temperature.
(2) " 4 " " " " " "
(3) " 6 " " " " " "

C. Berries Rotted
(1) Rotted 2 days
(2) " 4 "
(3) " 6 "

Samples of each lot were stratified at once (7/20/39) and sowing test at the end of 3 months was made. The germinations obtained, as well as the appearance of the seed, indicated that after-ripening was incomplete in all lots except A-1 and B-2; though 3 months' stratification starting 11/18/39 proved adequate for all lots. This rather contradicts the premise that the germ dormancy of chokecherry increases during the first few months of dry storage after extraction. The germination percentages from this first test were: A1 69%, A2 *0%, B1 16% (48% at 4 months' stratification), B2 72%, B3 1%, C1 9%, C2 29%, and C3 12%. (*) A2 seed was mouldy when sown, others sound but dormant.

Germination % from Samples Stratified 11/18-2/16/40

Storage	A1	A2	B1	B2	B3	C1	C2	C3	Average for Stg. method
Open, Whse.	*	76							76 (1 sample)
Sealed "	*	74	74	76		86		66	75 (5 samples)
Open, 34-40°F.	*	60	84	68	54	72	64	72	68 (7 samples)
Sealed, 34-40°F.	*	62	76	74	68	80	64	70	70 (7 samples)
Open, 26°F.	4		68						
Sealed, 26°F.		58	76						67 (2 samples)
Average for extraction lot		66	76	73	61	79	64	69	

*A1 was not held at the temperatures above freezing because previous trials all resulted in destruction by mould and heating of moist seed at these temperatures.

CONCLUSION: No temperature control or sealed storage is necessary for holding dry chokecherry seed for the short period from time of extraction until fall seeding or stratification. Two or four days' fermentation or rotting of the berries improves the viability of the seed.

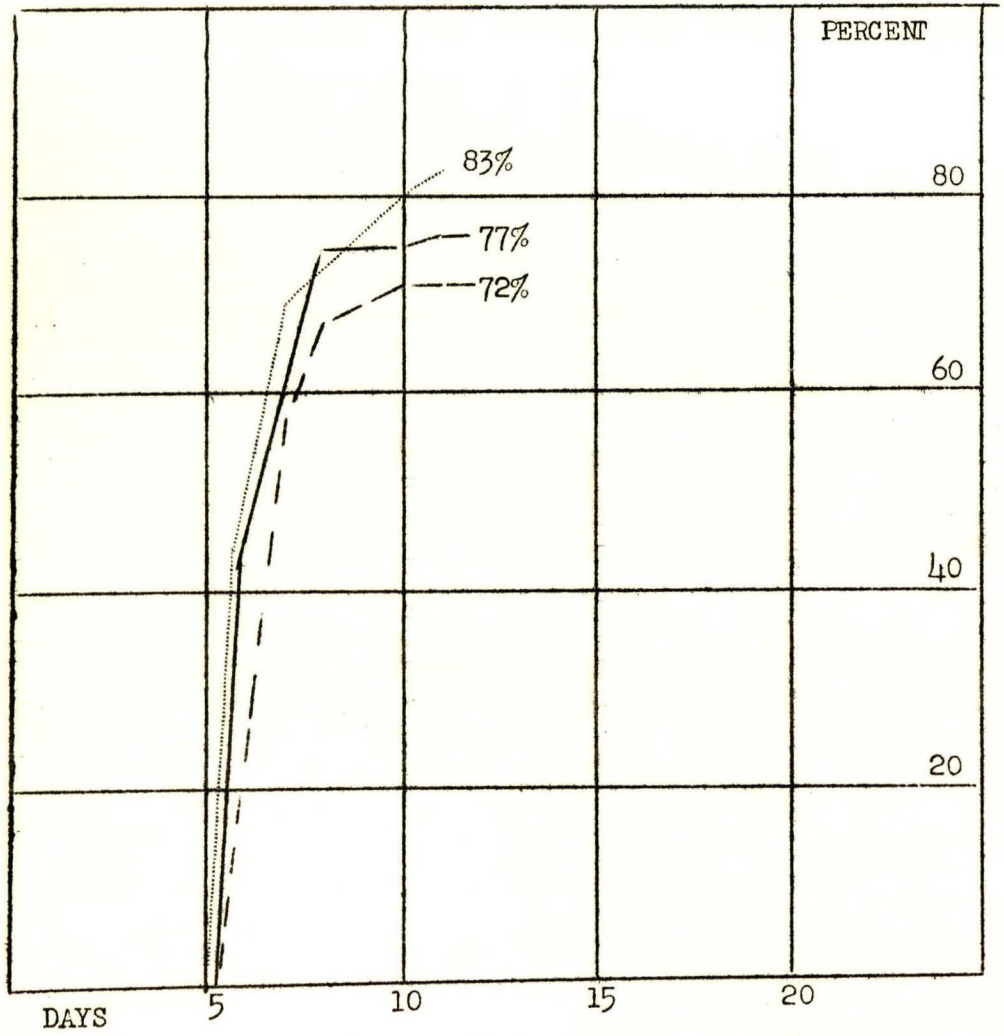
DATA: Samples of the lots shown on the previous tabulation were again stratified for a 3 month period, 9/13/40-12/17/40, about 14 months after extraction. Sown in flats of sand-peat mixture.

Germination %

Storage	A1	A2	B1	B2	B3	C1	C2	C3	Average for Stg. method
Sealed at Whse		2*	80	52		64	52	50	60
Open, 34-40°F.		28	40	50	48	8*	42	40	41
Sealed, 34-40°F.		52	64	76	76	74	76		70
Open, 26°F.		74							74
Sealed, 26°F.	0**		88						88
Average for extraction lot		51	68	60	62	69	57	45	

* Figures so marked, not included in averages.
** Rotten when planted; moist storage at higher temperatures had previously failed.

CONCLUSION: Storage at sub-freezing temperature is best. Storage at 34-40°F. in sealed containers, second best; and sealed storage at warehouse temperature third. Open storage at 34-40°F. is consistently poorer than sealed storage at warehouse temperature. Benefits of several days' fermentation or rotting of the fruits carries over into the second year. The lots showing highest total germinations also germinated earlier and faster, indicating lesser dormancy or greater vigor resulting from the extraction and storage methods used. Germination behavior of earlier lots indicates that severe sun-drying of the seed induces persistent germ dormancy which was unevenly and only partially overcome by stratification for 5 months at after-ripening temperature.



1. Stratified without previous drying
2. " after brief drying
3. Moist, moulded, dried, before stratified

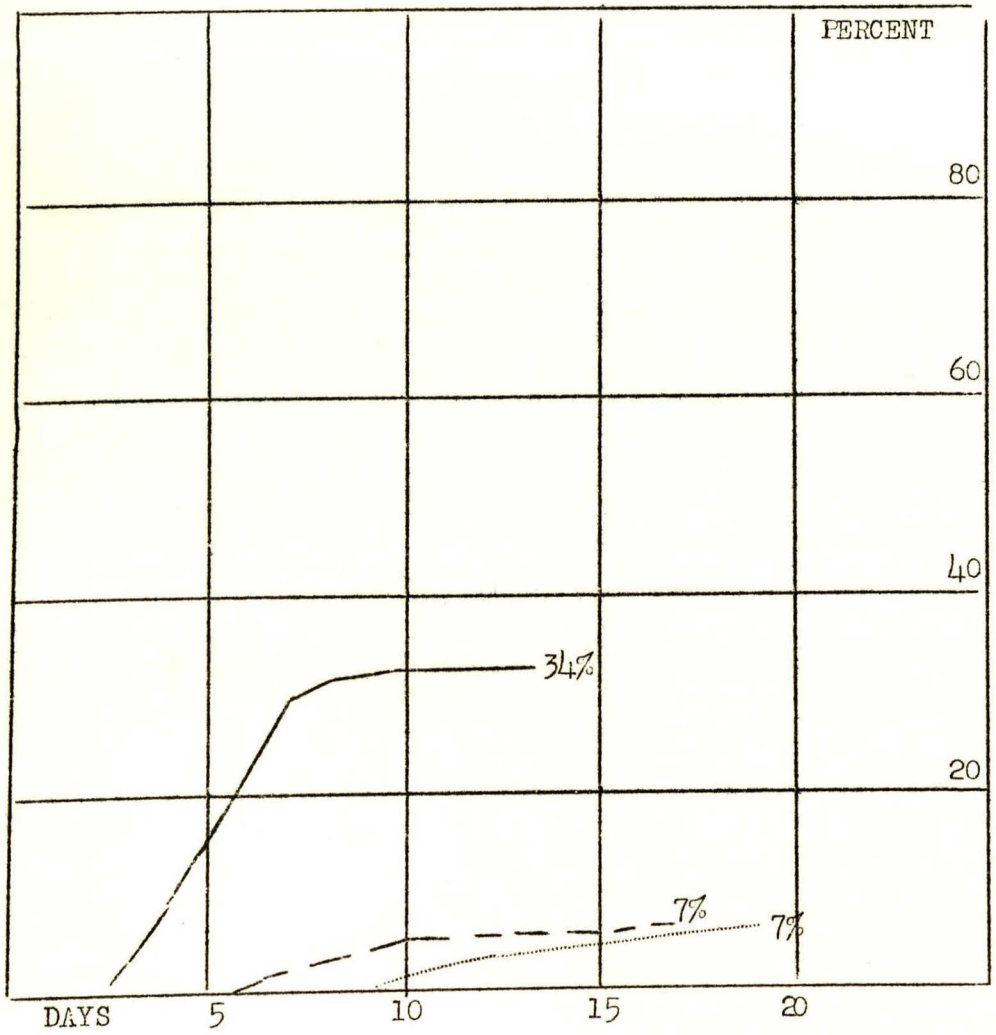
WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) F-36-7 Cho-2

Initial viability of seed F-36-7 before sun-drying and storage.

DATA: Seed was extracted from a small lot of berries and divided into three samples, which were:

1. Stratified at once without any drying.
2. Dried a few days indoors, then stratified 8/12/36.
3. Put in moist sand for storage; but they started to heat and mould, so they were cleaned and dried before stratifying.

CONCLUSION: All of the samples show high viability, the seed having brief drying being best. 3 1/3 months' stratification at after-ripening temperature was adequate. This test serves as a control for interpreting the behavior of the same general lot after sun-drying and four months' storage prior to stratification. (See Cho-3)



.....Stratified 3 months
— — — — " 3 1/3 "
——— " 3 3/4 "

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) Cho-3
F-36-7

Routine tests of sun-dried seed and sun-dried berries.

DATA: Random sample of main stores of Chokecherry seed which was sun-dried following extraction, stored dry from August to December and stratified 12/21/36, was tested at the intervals shown. Also, two bushels of sun-dried berries of the same crop were carried in stratification and tested at the same intervals. On 3/20/37 seedcoats of the clean seed were starting to fall apart.

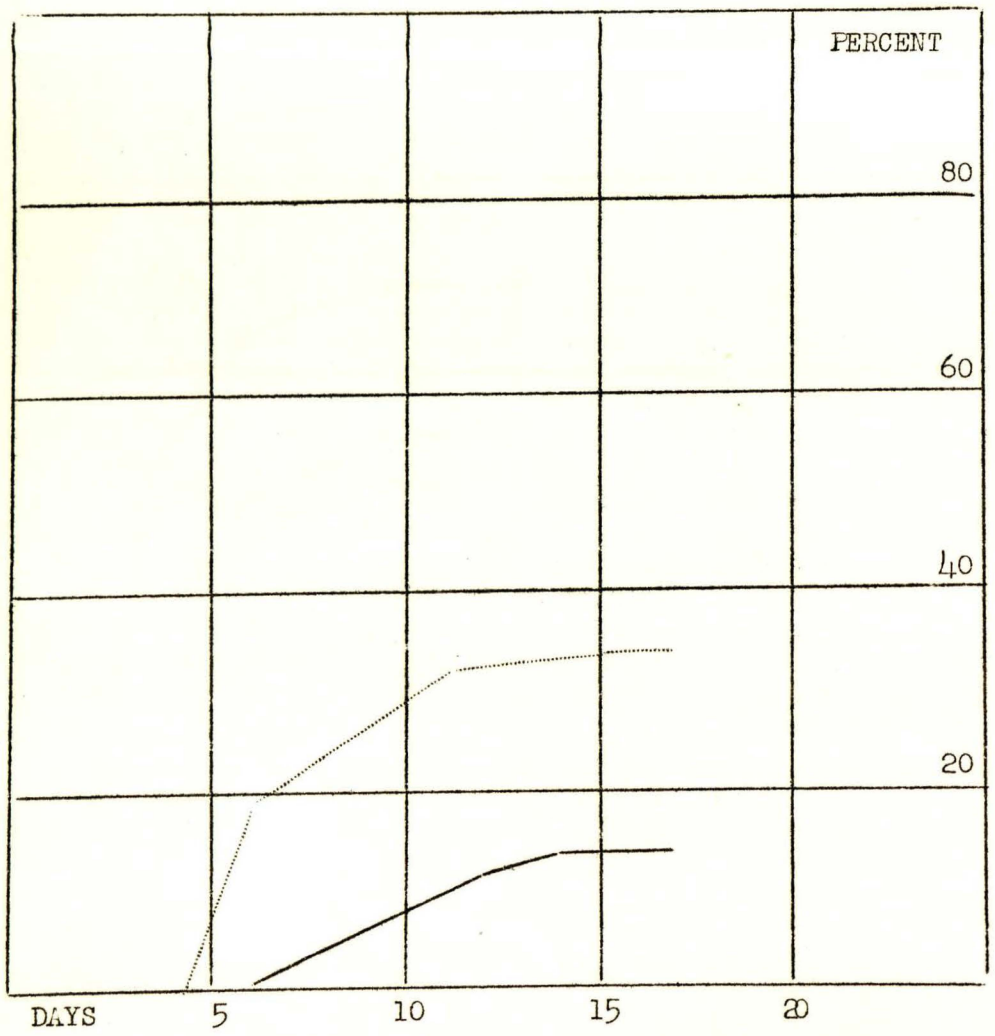
CONCLUSION: Persistent germ dormancy of this seed was only partially relieved by 3 3/4 months' stratification. Opening of the seed-coats is not a reliable indication that after-ripening is complete. None of the sun-dried berries were viable at the time of the last test.

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) Cho-4
F-37-6

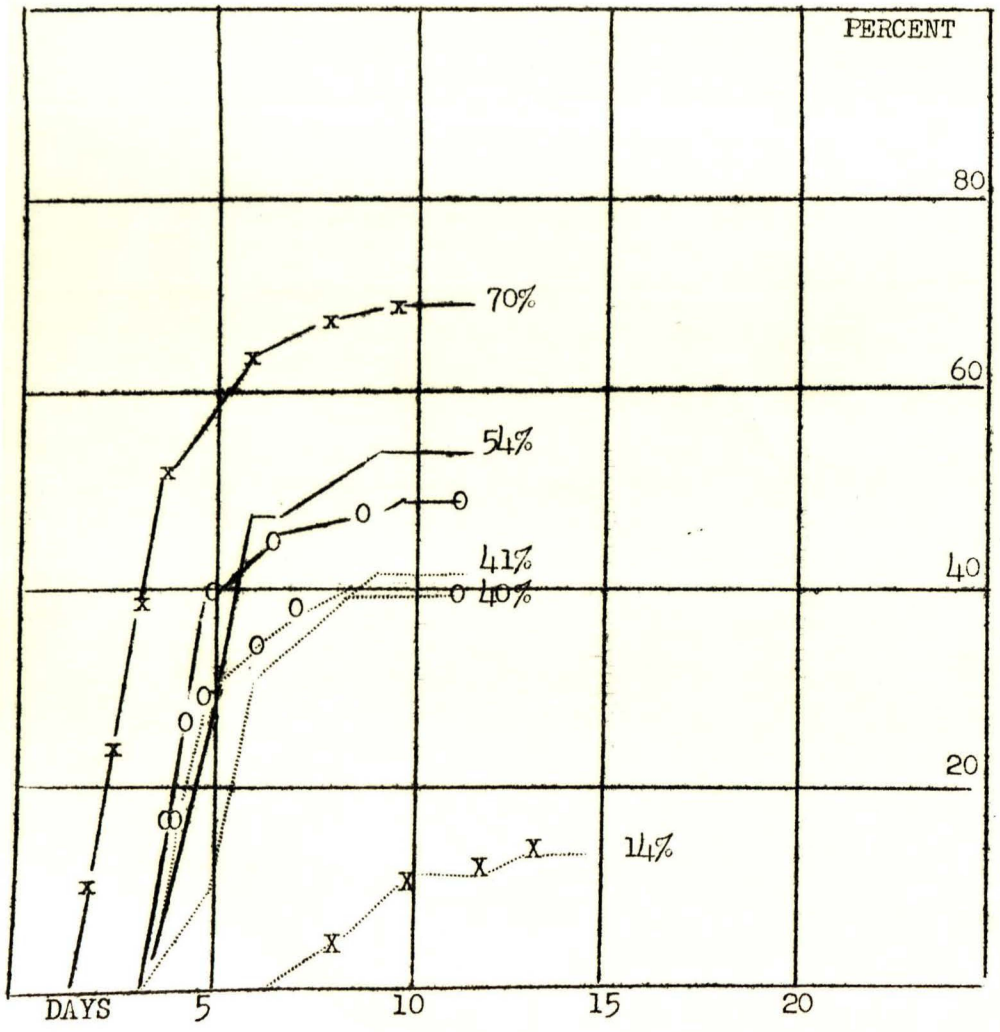
Routine test of seed supply.

DATA: Stratified at after-ripening temperature 12/17/37. Random samples sown 2/23/38 and 3/14/38.

CONCLUSION: Rather low viability had been obtained at the time of the last test.



——— Stratified 12/17/37, sown 2/23/38
..... " 12/17/37, " 3/14/38



———	Stratified	12/26/39,	sown 3/1/40	
—0—0—0—	"	12/26/39,	" 3/15/40	
—x—x—x—x	"	12/26/39,	" 3/22/40	(frozen)
.....	"	1/9/40 ,	" 3/1/40	
0..0..0..0.	"	1/9/40 ,	" 3/15/40	
X..X..X..X.	"	12/26/39,	" 4/5/40	(heated)

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) Cho-5
F-39-9

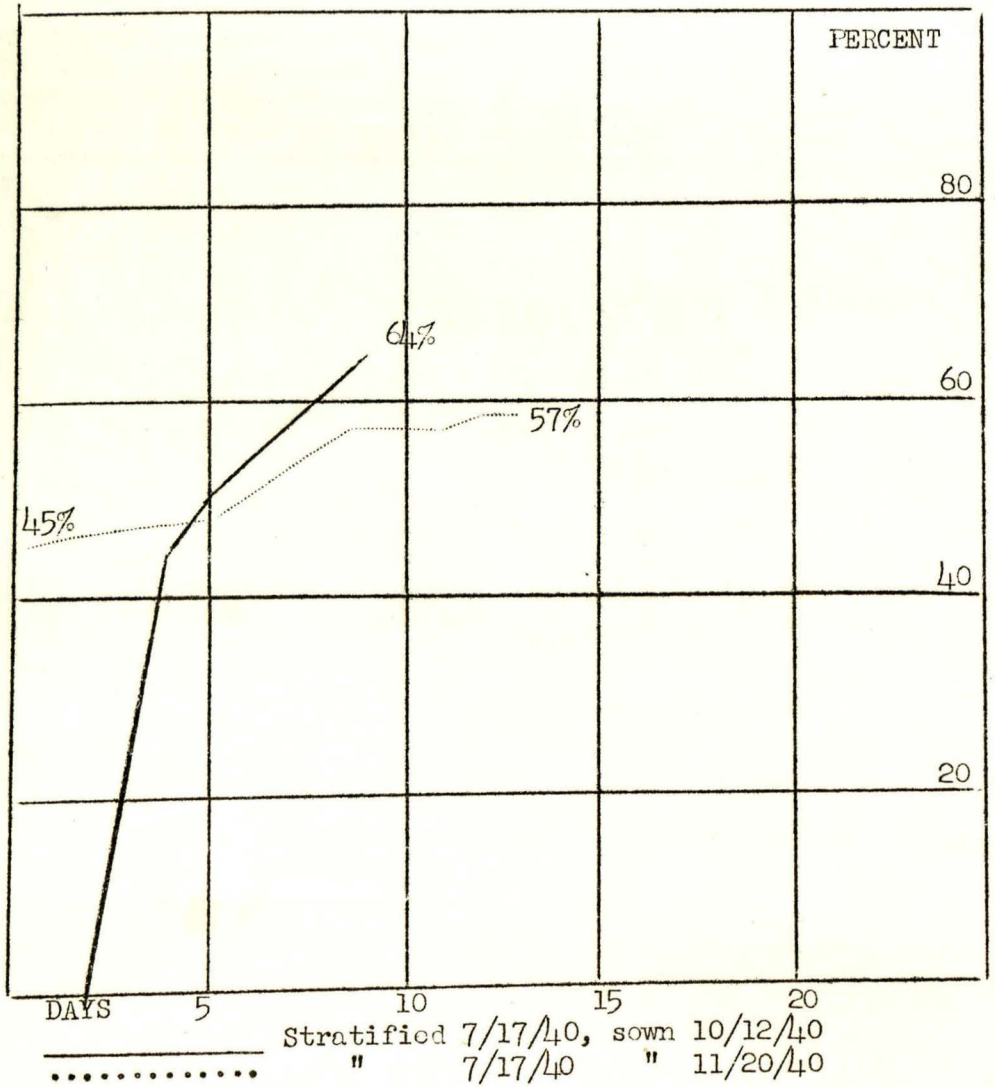
Routine tests of main stores. Shows damage by heating in stratification.

DATA: The seed was stratified in two lots, on 12/26/39 and 1/9/40, respectively. After-ripening was rapid, and sprouting at the after-ripening temperature (35-40°F.) began at about two months. To relieve the storage costs which were on a weight basis, and to reduce damage to seed from screening after more advanced sprouting had occurred, we screened out the peat on 3/11/40. The lot stratified 12/26 was transferred to sub-freezing temperature and the later lot held at 35-41°F. On 3/22, the lot at 35-41°F. was heating and had a temperature of about 85°F. It was spread out to cool, moistened and put in the freezer, in metal ice cans. By 3/30/40, the seed stratified 12/26/39 and held in the freezer since 3/11, in 2-bushel wooden boxes, was heating, some boxes severely. Both lots of seed had had only moderate drying indoors at time of extraction and was stored in closed metal drums at 35-45°F. from August to December.

CONCLUSION: This seed had less persistent germ dormancy than seed of previous year's handling, probably due to less severe drying. After-ripened Chokecherry seed will sprout at temperatures at or only a few degrees above freezing. Germination produces heat, even at freezing temperature; and if the seed is confined in quantities which prevent free relief of the heat, temperature rise and accompanying moulds may destroy the seed.

WESTERN CHOKECHERRY (Prunus virginiana melanocarpa) Cho-6

F-39-9



Tests of main stores after 1 year storage in closed metal drums at 35-45°F.

DATA: Random samples of our main supply of Chokecherry seed were stratified in moist peat at 35-40°F. 7/17/40, and sowing tests run 10/12/40 and 11/20/40.

CONCLUSION: The storage used retained most of the initial viability of the seed. After-ripening was completed by the time of the first test, 90 days' stratification; and had passed its prime at 4 months' stratification.